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(Recognosce notum, ignotum inspice)

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P. H. GREGORY and W. C. MOORE

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TWO NEW RUSTS FROM SOUTH INDIA

By T. S. RAMAKRISHNAN
Agricultural Research Institute, Coimbatore, India

(With Plate 4 and 5 Text-figures)

One new genus and two new species are described: *Gymnopuccinia* n.gen., with the type species *G. pulneyensis* n.sp. on *Toddalia asiatica*; and *Phakopsora fici-elasticae* n.sp., on *Ficus elastica*.

During recent months two rusts were collected: one from Kodaikanal, Madura district, on *Toddalia asiatica* (*T. aculeata*), and the other on *Ficus elastica* from the Botanic gardens, Ootacamund. On examination these are found to be peculiar and interesting and are described in this communication.

Gymnopuccinia gen.nov.

Pycnia amphigena, intra-epidermalia; uredia amphigena rara, subepidermalia, erumpentia; uredisoporae pedicellata; telia amphigena plerumque hypophylia, subepidermalia, in breviusculis columellis usque 2 mm. longis; teliosporae bicellulata, pedicellata, pedicellis hyalinis tandem gelatinosis.

Gymnopuccinia pulneyensis sp.nov.

Maculis amphigenis, flavis, orbicularibus vel irregularis, leniter tumidulis. Pycnia amphigena, aggregata, intra-epidermalia, flavo-rubreo colore, 160–220 μ diam. et 70–120 μ alt. Uredia rara cum pycnia immixta, subepidermalia, erumpentia; urediosporae pedicellata, oblonga vel obovata leniter angulata, membrane irregulariter crassa, minutae verruculosa, 30–56 × 22–28 μ. Telia hypophylla, gregaria, subepidermatae, in columellis usque 2 mm. longa; teliosporae bicellulata, stipitata, pedicello hyalino usque 75 μ longa tandem gelatinosa, 80 × 30 μ (50–102 × 24–37), clavata vel oblonga, medio constricta, flavo brunei-colore, episporia tecta, 1·5 μ crassa.

In vivis foliis et caulibus *Toddaliae asiaticae*, Kodaikanal, Madura district, 24 December 1949. K. V. Srinivasan and T. S. Ramakrishnan.

T. asiatica growing in the forests around Kodaikanal was extensively infected by a rust in December 1949. Yellow circular or at times irregular indefinite spots were formed on the leaves. In some instances the affected portions were thickened. Most of the spots were on the leaf blade, but rarely the petiole and small green twigs were also infected. In young spots numerous small yellowish red pycnia were developed, mostly on the upper surface but sometimes on both sides. In older spots a number of telia had formed on the lower surface. Uredia were very rare and only a few were observed on the specimens.

The pycnia were amphigenous and appeared as small yellowish red projections arranged in rings in the middle of the rust spots. They measured 160–200 μ in diameter and 70–120 μ in height. They were intra-epidermal and ostiolate. The contents were yellow. The uredia were very few. They were usually hypophyllous, subepidermal and erumpent. The urediospores

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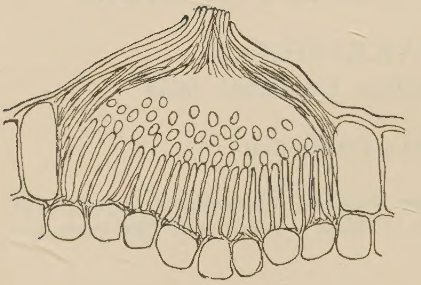
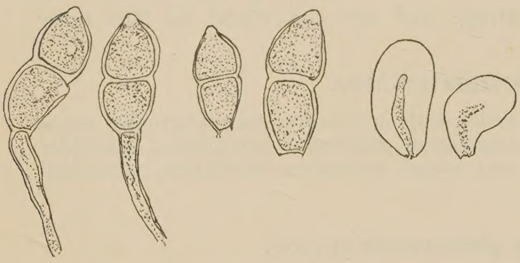
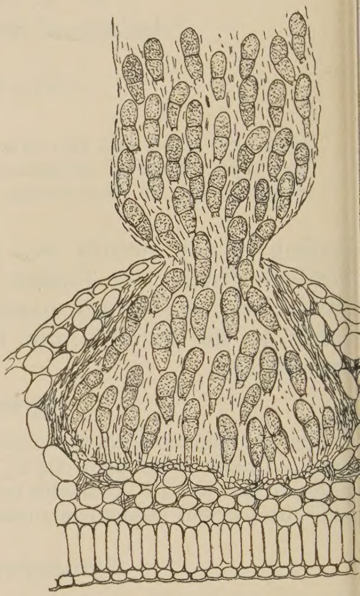


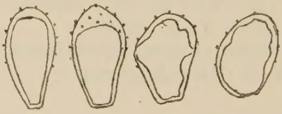
Text-fig. 2. *Gymnopuccinia pulneyensis*. Pycnium (× 200).



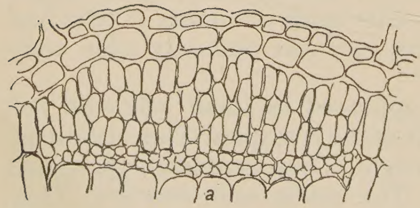
Text-fig. 3. *Gymnopuccinia pulneyensis*. Teliospores and swollen cells (× 200).



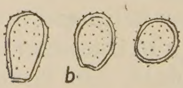
Text-fig. 2. *Gymnopuccinia pulneyensis*. Section through telium (× 65).



Text-fig. 4. *Gymnopuccinia pulneyensis*. Urediospores (× 300).



Text-fig. 5*a*. *Phakopsora fici-elasticae*. Section through telium (× 250).



Text-fig. 5*b*. *Phakopsora fici-elasticae*. Urediospores (× 300).

were stipitate, oblong or obovate, cinnamon yellow, with unequally thickened wall and measuring 36–58 × 20–25 μ.

The telia were few to many in a spot and hypophyllous or caulicolous. They were sometimes developed all round a central group of pycnia. Each telium was deep seated and in young stages the epidermis was raised as a dome. Later the teliospores were extended in short columns 0·5–2 mm. in length through a slit in the epidermis. The columns were brown when fresh, but on drying developed a brownish white fluffy appearance. The columns were straight or bent.

The teliospores were two-celled, stalked and embedded in a gelatinous matrix. They were formed in succession but not in chains; nor were they united to one another. The stalks were thin walled, hyaline and easily gelatinizing. Consequently, some spores had stalks up to 75 μ in length (as long as the spores) with the lower portion partially dissolved; others had much shorter stalks and in still others the stalk had completely disorganized and only a scar was visible or even this was not clear. Mixed with the spores were several stout, hyaline, sterile, gelatinized cells evidently produced from the sporogenous tissue, and contributing to the gelatinous matrix. These were oblong or bent with a glassy body and a central granular protoplasmic core. These cells had a scar denoting the place of attachment at one end and the protoplasmic core originated from this end. The teliospores were oblong or spindle-shaped and light brown in colour. Some of the spores had broad apices while others were tapering. The spores averaged 80 × 30 μ (range 50–102 × 24–37). The two cells were equal in size or one or the other was bigger. The upper cell measured 40 × 30 μ (27–48 × 14–37) and the lower one 41 × 29 μ (31–58 × 14–37). There was a prominent constriction at the septum. The wall was thin, up to 1·7 μ in diameter, and without any thickening at the apex. In the upper cell was one apical germ pore which often appeared papillate. In the lower cell one germ pore was distinct near the septum but some spores had two. Germination was evident when the spores were floated in drops of water. The spores readily collapsed on the slightest pressure. In many cases the two cells separated along the septum into one-celled units.

The shape of the teliospores is as in *Puccinia*. The gelatinization of the stalk and the extrusion of the spores in columns suggest relationship with *Gymmosporangium*. Dr Bisby, who was consulted about the identity of the fungus, was of the opinion that it must be placed in a new genus.

Doidge (1926, p. 95) has described *Puccinia lemanensis* on *Toddalia aculeata* from the Transvaal. The telial stage alone was noticed and the general description and the figures exhibit a vague resemblance to the rust under study excepting for the size of the spores, but there is no mention of their extrusion in columns or of a gelatinous matrix in this rust. Thirumalachar and Mundkur (Thirumalachar, 1942) described *Didymopsora toddaliae* and *D. macrospora* on two varieties of *Toddalia aculeata* from Mysore. It was not possible to obtain the type specimen of *Puccinia lemanensis* but an authentic specimen of *Didymopsora toddaliae* was obtained from the Indian Agricultural Research Institute, New Delhi, for comparison. This exhibited very close resemblance to the rust under study. The only difference noted was in the size of the teliospores.

In the genus *Didymopsora* the teliospores are sessile. But in the rust under study and in *D. toddaliae* the teliospores exhibited the presence of pedicels in various stages of gelatinization. Thirumalachar (1942) states that the 'basal spore is borne on a basal cell which however is not present in the mature spore at the top', and again 'some of the teliospores retain short basal cells'. His sketch of the telium, however, appears to show the lowermost row of the spores as being stalked. He has also stated that the teliospores were in chains, though in the specimen of *D. toddaliae* there was no evidence of this. In the specimen of *D. toddaliae* and the rust under study, perfect stalks were noticed, and these were gradually collapsing and forming part of the gelatinous matrix. There was nothing to warrant the assumption that these were not stalks. The possession of the stalk decides that the rust cannot be *Didymopsora*. Further, the characters of the rust are different from those of other known genera. It is proposed to erect a new genus *Gymnopuccinia* to accommodate this rust. This name has been adopted as the rust is found to resemble *Gymnosporangium* and *Puccinia*. The rust is named *Gymnopuccinia pulneyensis* (the epithet from Pulney, a geographic area of Madura).

Phakopsora fici-elasticae sp.nov.

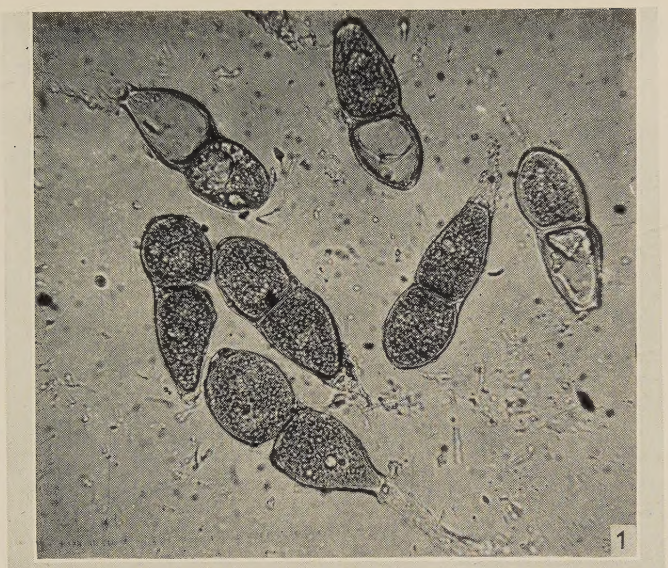
Pycnia et aecia ignota; uredia hypophylia, sparsa vel gregaria, erumpentia, paraphysata, paraphyses cylindrici vel clavati, paraphysibus periphaeralis numerosis, incurvatis, subhyalinis. Urediosporae stipitata, subglobosa, 22 × 17 μ (17–31 × 15–24), subhyalina, breviter echinulata; telia subepidermata, non erumpentia, hypophylia, compacta; teliosporae sessilia, 4–6 seriatum disposita, oblonga vel angulata, levi brunneocolore, 11–16 × 5–8 μ, membrana tenuissima.

In foliis vivis *Fici elasticae*. Ootacamund, Nilgiris, 22 February 1950—T. S. Ramakrishnan.

Ficus elastica growing in the Botanic gardens, Ootacamund, Nilgiris, was affected by a rust at the beginning of 1950. Uredia and telia were present on the lower surface of the leaves. The former were prominent as hemispherical raised structures and occurred singly and scattered, or in groups of two to six or more sori. The sori were 120–220 μ broad and 75–140 μ high, deep-seated and covered over by the double-layered epidermis. The covering was irregularly ruptured, exposing the white powdery mass of spores. Urediospores were stalked, subglobose, thin-walled, subhyaline, finely echinulate and 22 × 17 μ (17–31 × 15–24 μ). Two germ pores were visible in some of the spores. Thin-walled subhyaline paraphyses were present, concentrated along the periphery of the sori or sometimes mixed with the spores. Those on the periphery were in more than one row and incurved while those in the middle were cylindric and straight or flexuous.

The telia were few and were situated near the uredia. They were subepidermal, non-erumpent, compact and light brown in colour. The teliospores were many layered (4–6), sessile, closely packed, not catenulate, oblong to angular, thin-walled and separating when the sorus was teased out. They measured 11–16 × 5–8 μ.

This rust has all the characteristics of *Phakopsora*. It differs from *Cerotelium fici* in the absence of catenulate teliospores as well as in the general appearance of the sori. It is named *Phakopsora fici-elasticae*.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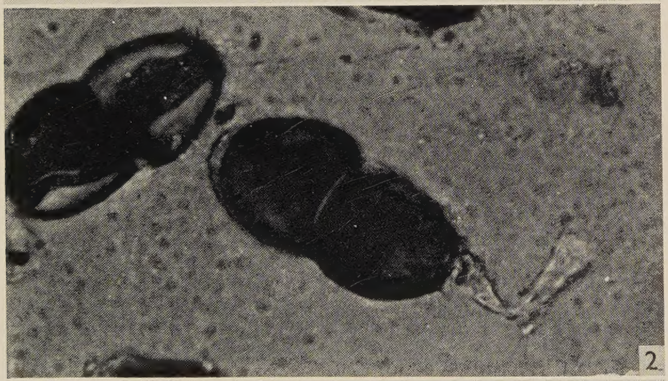
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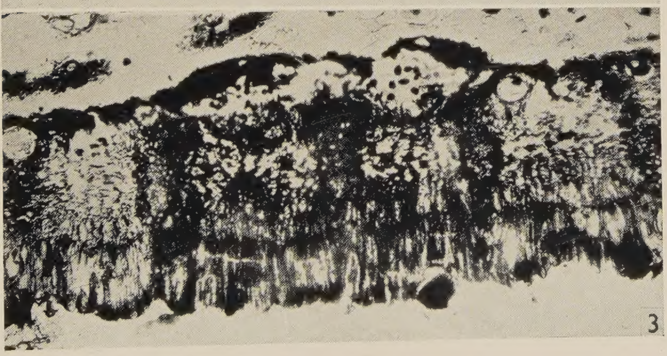
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I am grateful to Dr Bisby for help rendered in the preparation of this aper. My thanks are due to Dr R. S. Vasudeva, Head of the Division of ycology, Indian Agricultural Research Institute, New Delhi, for kindly pplying the authentic specimen of *Didymopsora toddaliae*.

REFERENCES

OIDGE, E. M. (1926). A preliminary study of the South African rust fungi. *Bothalia*, **2**, 1–228.

HIRUMALACHAR, M. J. (1942). Two new species of *Didymopsora*. *Proc. Indian Acad. Sci.* **16**, 165–174.

EXPLANATION OF PLATE 4

Fig. 1. Teliospores of *Gymnopuccinia pulneyensis*, showing pedicels. (× 400.)

Fig. 2. Teliospores of *Didymopsora toddaliae*, one showing pedicel. (× 800.)

Fig. 3. Section through uredia of *Phakopsora fici-elasticae*. (× 300.)

(*Accepted for publication* 16 *May* 1950)

THE DEVELOPMENT OF *ARMILLARIA MELLEA* RHIZOMORPHS IN A WATER TUNNEL

By W. P. K. FINDLAY
Forest Products Research Laboratory, Princes Risborough

(With Plate 5)

It is well known that the rhizomorphs of *Armillaria mellea* (Fr.) Quél. can attain considerable lengths, and it is not unusual to find extensive wefts of the strands spreading over pit props in very damp coal mines.

A case of exceptionally vigorous growth in water was discovered by Mr D. G. Davies, Manager of Harrogate Waterworks, in Carlesmoor water carrying tunnel leading out of Roundhill reservoir. The tunnel at this point is in hard rock 200 ft. below ground level and there is no possibility of any tree roots having penetrated to this depth. The growth illustrated in Pl. 5, which originally measured about 10 ft. in length, was found growing out of a weep hole in the brickwork wall of the tunnel, just above the level of the water, while the rest of the plant was floating freely in the water. The whole of the specimen illustrated is known to have grown during the course of four years. Mr Davies informs me that, on a previous inspection of the tunnel, a similar growth 30 ft. in length was found growing from another weep hole and that this must have grown in seven years or less.

No woodwork is now visible in the tunnel, which is lined throughout with brick and concrete, but it is possible that some timber shoring was left *in situ* when the tunnel was lined, as the rock may have been heavily fractured when the tunnel was driven. It is surprising that the fungus has been able to grow so vigorously in wood that must have been more or less saturated with water and to which access of air must have been very restricted.

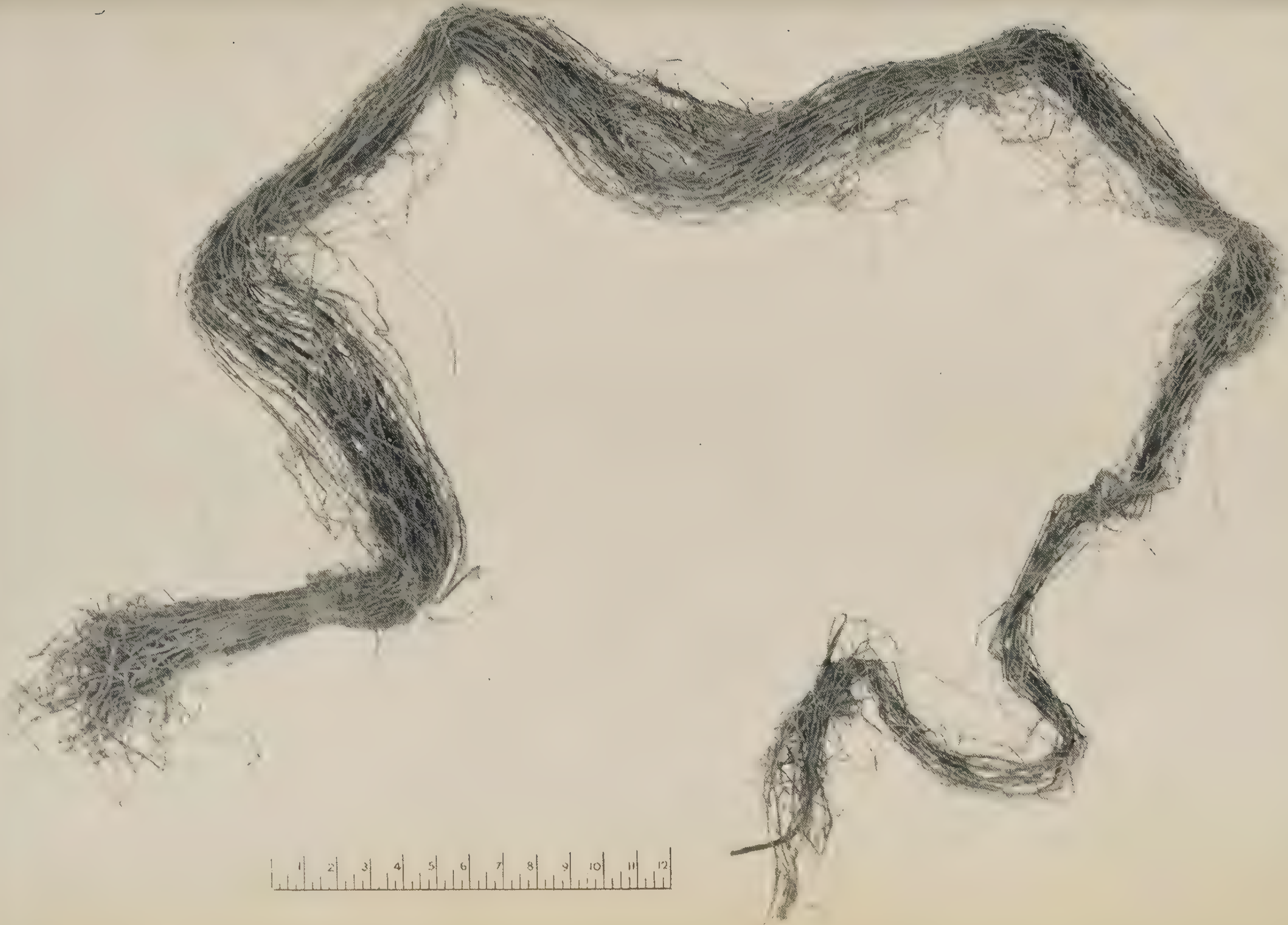
It provides an interesting demonstration of the effectiveness of the mechanism for the transport of metabolic products along a fungal strand. There is here no question of the hyphae in the strand being able to absorb any appreciable quantity of nutrients from the surrounding medium which was clean water, so that all the nutrients necessary for continued growth of the fungus strands must have been transported for distances up to 30 ft. A similar problem is presented by the growth for long distances through brickwork of the strands of *Merulius lacrymans*; the mechanism by which fluids and metabolic products travel along such strands would seem to merit further investigation.

I am indebted to Mr Davies for the information he kindly supplied about the tunnel and to the Director, Forest Products Research, for permission to publish this note.

EXPLANATION OF PLATE 5

Rhizomorphs of *Armillaria mellea* from water tunnel. (Scale in inches is shown.)

(*Accepted for publication* 3 *June* 1950)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BRITISH MARSH AND FEN FUNGI. I.

By M. B. ELLIS, *Commonwealth Mycological Institute, Kew*
E. A. ELLIS, *Castle Museum, Norwich*
and J. PAMELA ELLIS

(With 14 Text-figures)

Ten fungi found on marshes and fens in Great Britain are described and figured, viz.: *Clasterosporium caricinum, Curvularia crepini, Napicladium arundinaceum, Passalora depressa, Dendryphiella interseminata, Triposporium elegans, Helicosporium phragmitis, Speira toruloides, Stachylidium bicolor, Sporoschisma mirabile.* Notes are made on spore dispersal, spore germination, times of occurrence, host or substratum range and the cultural characters of some of them.

1935 Corner gave a short account of some fungi collected at Wicken , Cambridgeshire, and in 1941 E. A. Ellis listed a number of micro- gi found at Wheatfen Broad, near Surlingham in Norfolk. In the tices of British Fungi', Berkeley and Broome described several species nd in marshy places, and in these *Transactions* and in other journals e are notes on collections made by W. B. Grove, D. A. Boyd and dred collectors who ventured into many different habitats in search of cimens. The fungi of marshes and fens have not been at all fully in- igated, however, and there are singularly few references to them in the ish Mycological Society's foray reports; little work has been done on r biology and very few species have been studied in culture. In the ent series of papers we intend to describe and figure many of the species nd in these habitats and hope by so doing to stimulate other mycologists ake an interest in them. Fungi of marshes and fens present many resting biological problems, but these may be tackled satisfactorily when specimens can be readily identified. Slides and specimens are ilable in Herb. I.M.I. and Herb. E. A. Ellis.

(1) **Clasterosporium caricinum** Schweinitz in *Trans. Amer. Philos. Soc.* 15 April 1831, N.S. **4**, 300 (1834).

his beautiful and interesting hyphomycete, the type species of *Clastero- ium*, was first seen in America and described there by L. D. von Schwei- . In England it grows on the broad-leaved sedges *Carex acutiformis* and *iparia*, and has been found once on *C. elata. Clasterosporium caricinum* is e common at Wheatfen Broad and at one or two other places in Nor- ; it also occurs at Flatford Mill in Suffolk and at Wood Walton Fen in ntingdonshire.

oung colonies of the fungus cause no local discoloration of the host es but the leaves are eventually killed. On 11 March 1948 two plants of *x riparia* were flagged: one plant bore leaves with a few very young nies of *Clasterosporium caricinum* on their bases, the other plant showed

no signs of attack. Both plants at this stage were quite green. On
March 1948 the leaves attacked by the fungus had started to die back fro
their tips, and by 13 June the leaves were brown and dead right to the bas
on the dead leaves, which were up to 120 cm. long, the fungus coloni

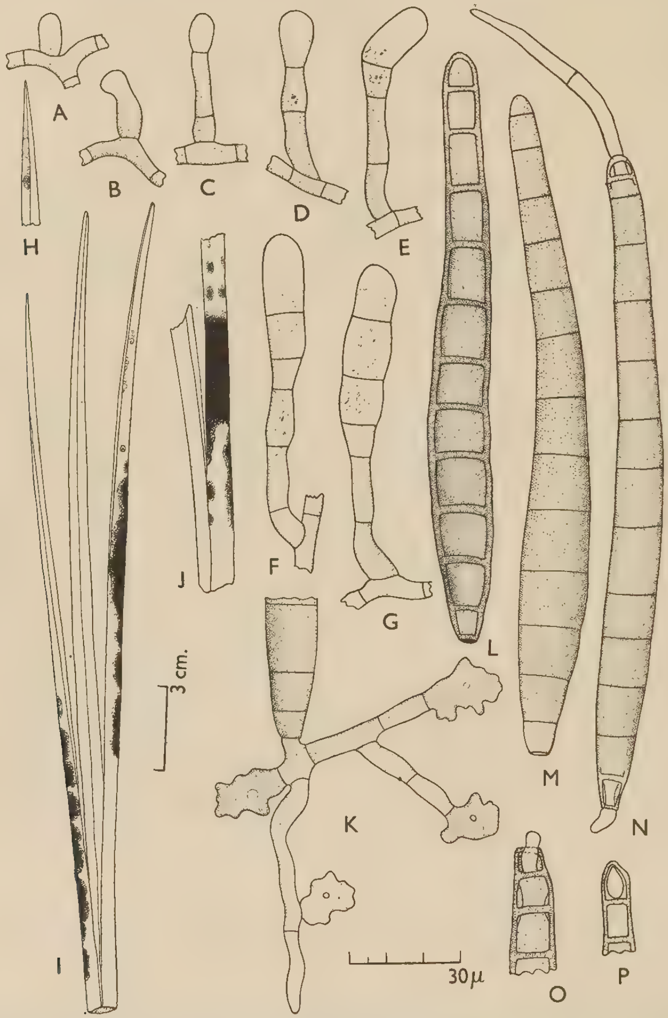

Fig. 1. *Clasterosporium caricinum.* A–G, development of conidiophores and conidia; H–J,
pearance of colonies on the host plant; K and N–P, germinating conidia, in K four hyp
podia have been formed; L, M, conidia.

extended upwards for 24 cm. from the base. All leaves on the conti
plant were still quite green on 13 June. The conspicuous black, velve
colonies (Fig. 1 I, J) are confined mainly to the abaxial surface of the l
bases, although they also occur on the tips of young green leaves (Fig. 1 H
they are seldom found at a height of more than 30 cm. above the soil. C
colonies often cover the whole width of the outer surface of a leaf base a

may spread around its edge on to the inner surface; they vary in length from a few mm. to 24 cm. *C. caricinum* is initially parasitic on green leaves and is structurally adapted to this mode of life. The mycelium is always superficial and adheres closely to the leaf surface. In young colonies the mycelial network is an open one (Fig. 2A) and is composed of hyaline to pale brown, smooth-walled, branched and anastomosing, septate hyphae, 3–6 (4·5) μ in diameter, with cells 14–78 (34) μ long, on which are borne laterally and occasionally terminally, pale brown lobed hyphopodia. These hyphopodia vary in shape (Fig. 2E) and are 14–24 (16·5) μ long and 10–20

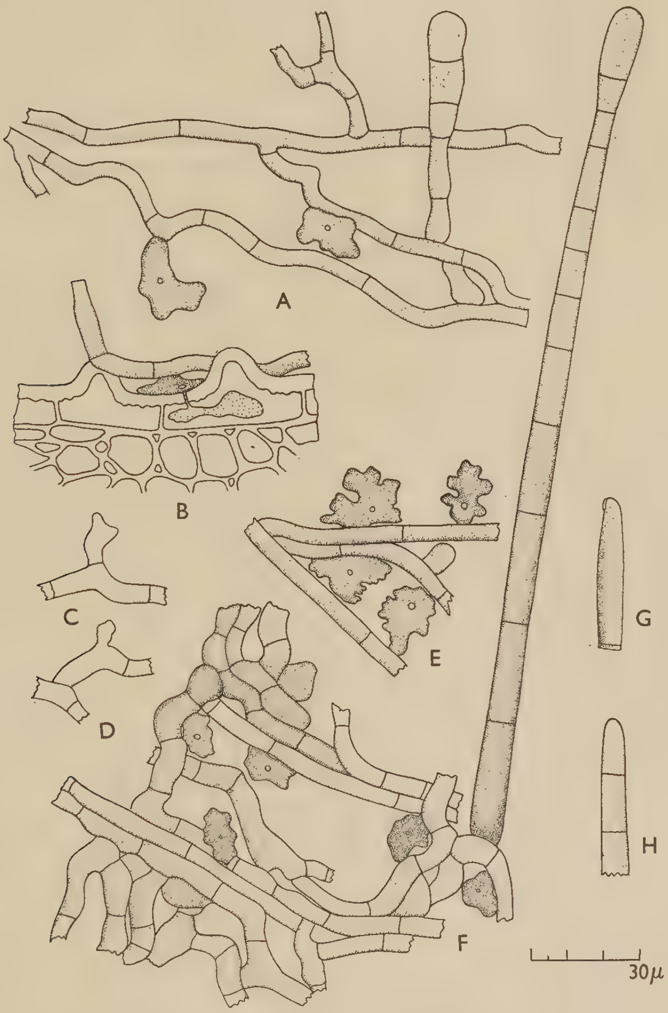

Fig. 2. *Clasterosporium caricinum.* A, mycelium, with developing conidiophore and conidium from a young colony; B, section through a leaf showing the haustorium in an epidermal cell; C, D, young hyphopodia; E, mature hyphopodia in surface view; F, mycelium, with seta, from an old colony; G, H, tips of setae.

(14·9) μ wide; a pale spot in the centre of each hyphopodium indicates the point of emergence of a thin strand of mycelium which penetrates the cuticle of the leaf to form a haustorium in the epidermal cell below (Fig. 2B). When the host leaves eventually die the fungus continues to live on, for a time, as a saprophyte on the dead leaves, and the mycelium proliferates to form an almost solid mass of thick, closely interwoven and anastomosing hyphae which are up to 8 μ in diameter; they bear numerous rather small hyphopodia (Fig. 2F). Conidia are borne singly at the apex of hyaline to brown, smooth-walled conidiophores (Fig. 1A–G) which are produced laterally on the hyphae in large numbers; occasionally a conidiophore is formed at the tip of a hypha. Conidiophores borne on the upper side of a hypha are usually straight, others curve to bring their main axis at right angles to the leaf surface; they are always unbranched. In young colonies the conidiophores are hyaline or very pale brown, 9–52 (22) μ long, 4–7 (5·8) μ in diameter, with 0–3 septa; in older colonies they are up to 130 μ long, dark brown, and have up to 7 septa. The conidia (Fig. 1L–N) are straight or slightly curved, smooth-walled, septate (with 7–17 septa), hyaline when young, dark brown below the middle and pale brown above when mature, varying in length from 70 to 360 μ (average of 100 measurements 164 μ); they are truncate at the base where they measure 4–8 (5·7) μ, and above this point swell rapidly, within a distance of 15–40 μ, to 11–20 (14·4) μ, then taper gradually to 5–11 (8·2) μ at the rounded apex. The conidia are formed from the swollen apex of the conidiophore (Fig. 1C–G), and in the early stages of development it is difficult to make out the eventual point of abscission. In old colonies on dead leaves the mycelial mat often bears straight, dark brown, thick-walled setae which are 230–460 (352) μ long, 7–10 (8·9) μ in diameter at the base, 9–10 (9·9) μ in the widest part and 5–7 (6) μ at the apex (Fig. 2F). When young the tips of these setae are often hyaline and swollen, giving one the impression that conidia are being formed; later, however, the swellings collapse and their shrivelled remains are seen at the apices of the older setae (Fig. 2G, H).

The sedges on which *C. caricinum* occurs have been found growing only on marshes and fens which are subjected to periodic flooding. The large conidia of the fungus have been found floating on the surface of dykes but have never been caught on spore traps in the air; it is probable that flood water plays an important part in their dispersal. The conidia sometimes float for a long while, up to 19 days; when first placed in water they are extremely buoyant and difficult to submerge; when they eventually sink they do so at the rate of approximately 2·4 cm. per minute.

C. caricinum does not grow on ordinary media such as potato-dextrose, malt, maize or oatmeal agars, nor was it found possible to grow it on cut leaves of *Carex riparia* which had been sterilized with propylene oxide. Conidia from a collection made in May 1947 were immersed in tap water on a slide, placed in a damp chamber on 28 May and examined thereafter every two or three days; no germination took place, although the conidia remained in the water for more than a month. On 10 February 1948 freshly collected conidia were mounted in water on two slides; a small piece of a young green leaf of *C. riparia* was placed in the water on one of the slides. After 48 hr. in a damp chamber the percentage germination in tap water alone was nil and in tap water with leaf 94%. Germ tubes, which grew out at both ends of the conidia, were simple, hyaline, cylindrical, 2–80 (52) μ long, 3–5 (3·6) μ in diameter; hyphopodia were formed at the tips of the primary germ tubes and on branches arising from them (Fig. 1 K and N–P). When leaves which had been sterilized with propylene oxide were used no conidia germinated. In a later set of experiments, using tap water alone and with leaves of *Dactylis glomerata* and *Phragmites communis*, some of the conidia germinated. It was thought at first that the presence of fresh green *Carex* leaves might be an essential factor in spore germination and it is possible that the conidia, which in the later set of experiments germinated in tap water and in the presence of other leaves, had received some initial stimulus from prior contact with their host plant.

(2) **Curvularia crepini** (Westend.) Boedijn in *Bull. Jard. bot. Buitenz.* Sér. 3, **13**, Livr. 1, 128 (December 1933).

Helminthosporium crepini Westend. in *Bull. Acad. Belg.* Sér 9, **2**, 656 (1861).
Brachysporium crepini (Westend.) Sacc. in *Syll. Fung.* **4**, 430 (1886).

This fungus grows on living leaves of *Ophioglossum vulgatum*; it was collected for the first time in Great Britain by A. Burges at Dernford Fen in 1935, but there are no published records of its occurrence in this country. It has been found several times during July and August at Wheatfen Broad and Hickling Broad in Norfolk. Colonies, which are found on both the upper and lower surfaces of the leaves, are grey at first and black later; newly established colonies are from 0·5 to 2 cm. in diameter but they soon spread and fuse and, finally, cover nearly the whole surface of the leaf. Washed 'necol' preparations and sections show that there is no superficial mycelium; the hyphae ramify freely through the substratum forming an extensive open network between the cells of the parenchyma and below the cuticle (Fig. 3 G). The hyphae are hyaline to pale brown, smooth-walled, 2–6 μ in diameter, with cells 7–25 μ long; hyphae at the point of origin of the conidiophores (Fig. 3 F, H and I) are pale brown to brown, 4–10 μ in diameter, with cells 7–20 μ long. The conidiophores (Fig. 3 A, B) are formed terminally and laterally on thickened branches of the mycelium; they arise singly or in groups of 2–8 and emerge through the cuticle, and when young are often acutely pointed at the apex (Fig. 3 E). Mature conidiophores are cylindrical, straight or flexuous, often swollen at the point of emergence, both above and below the cuticle (Fig. 3 F, I), tapering towards the apex where they are sometimes geniculate or wavy, with clearly defined conidial scars (Fig. 3 C); they are unbranched, smooth-walled, pale brown at the apex shading to mid-brown at the base. Length 70–160 (101) μ; diameter at base 8–11 (8·5) μ, immediately above the swollen base 6 μ, at the apex 2–5 (3·6) μ; with 1–7 septa. The conidia (Fig. 3 D) are arranged in a short spiral behind the apex of the conidiophore, the youngest conidium being nearest to the tip. Conidia are usually curved, rounded at the apex, narrowed and truncate at the base; the third cell from the base is wider than the others and the two end cells are usually much paler than the middle ones. Length 20–28 (25) μ; diameter of basal scar 1·5–2 (1·9) μ, of the second cell 8–10 (8·9) μ, of the third cell 10–14 (12) μ; with 3 septa. *Curvularia crepini* was grown on maize agar for seven weeks. The colonies were dark sepia, 85 mm. in diameter and bore numerous conidia on the closely packed conidiophores. The mycelium, which was mostly embedded in the substratum, was composed of hyaline to pale brown, smooth-walled hyphae, 2–4 μ in diameter, with cells 11–28 μ long; hyphae at the point of origin of the conidiophores (Fig. 4E) were pale brown, 3–5 μ in diameter, with cells 12–31 μ long. The conidiophores (Fig. 4B, C and E) were similar to those formed on natural substrata but were much narrower at the base and were sometimes branched (Fig. 4D). Length 36–240 (141) μ; diameter at the apex 4–7 (5·1) μ, at the base 3–5 (4·1) μ; with 2–14 septa. The conidia (Fig. 4A) were longer and more irregular in shape than those seen on the

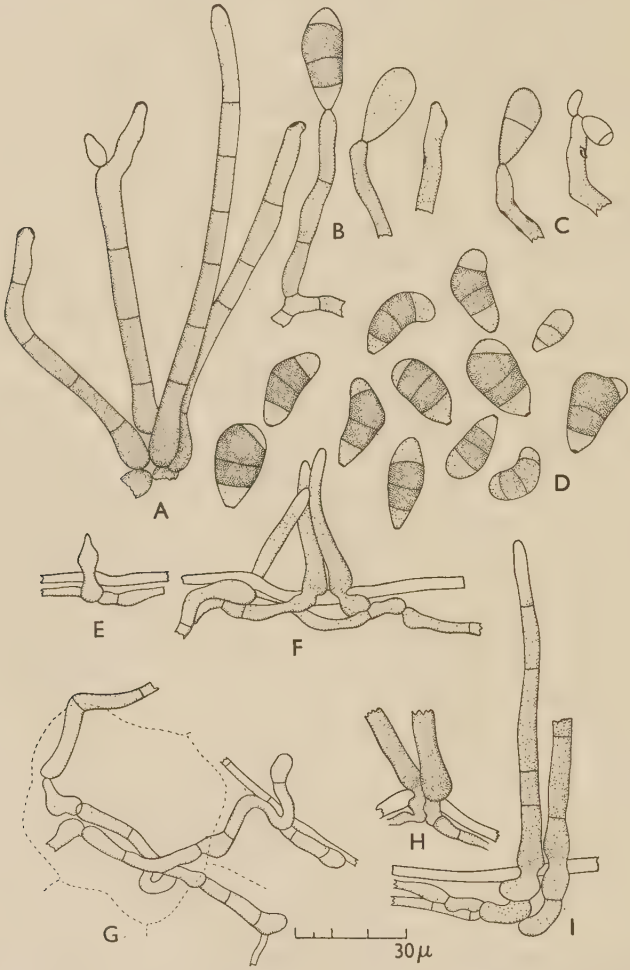

Fig. 3. *Curvularia crepini* A, B, conidiophores; C, young conidia attached to ends of conidiophores; D, conidia; E, F, young conidiophores; G, mycelium; H, I, bases of conidiophores.

most plant, additional septa were often formed and the conidia were sometimes three-cornered. Length 16–51 (35·4) μ; diameter at scar 1·5–2 (1·9) μ, of second cell 7–12 (8·8) μ, of third cell 7–16 (12·3) μ.

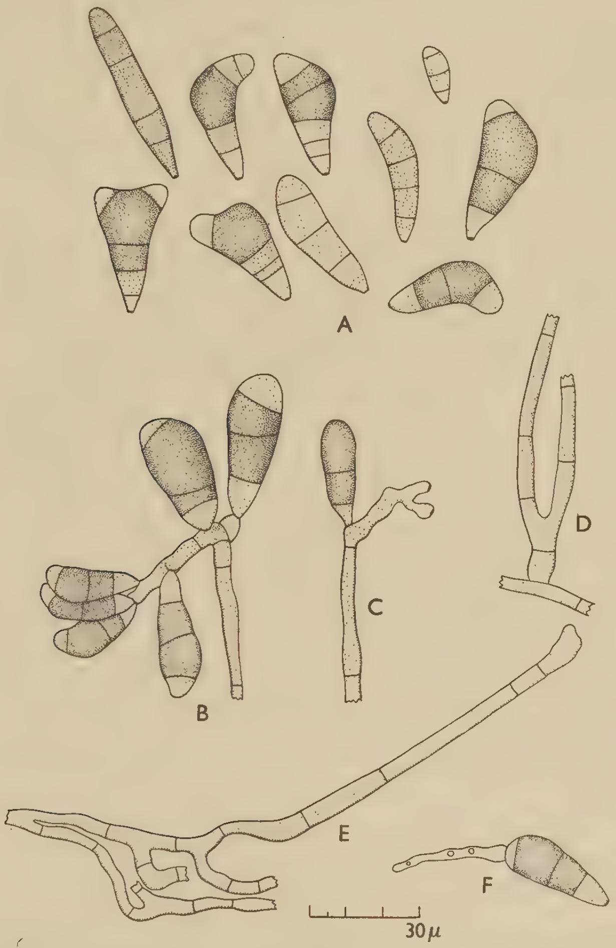

Fig. 4. *Curvularia crepini* in culture on maize meal agar. A, conidia; B, C, conidia attached to conidiophores; D, E, conidiophores and mycelium; F, germinating conidium.

(3) **Napicladium arundinaceum** (Corda) Sacc. in *Syll. Fung.* **4**, 482 (1886).

Helmisporium arundinaceum Corda in *Icon. Fung.* **3**, 10 (1839).

The first British collection of this species was made by C. B. Plowright at King's Lynn in August 1874. Recent collections from Norfolk, Guernsey and Kent have been examined; the fungus is usually in good condition from April to September. *Napicladium arundinaceum* is found on plants of *Phragmites communis* where these grow on hard ground along the sides of paths; neighbouring reeds growing on softer ground do not seem to be attacked. Infection is systemic and both inter- and intra-cellular mycelium was found abundantly in sections cut at different levels through the roots, rhizomes, culms and leaves. In transverse and longitudinal sections thick hyphae were seen passing through the vessels (Fig. 5 C, G). Sporulation takes place on both surfaces of the leaves and on the abaxial surface of the leaf bases. When the fungus starts to form spores infected plants may be detected easily, not only by their stunted growth, but by the grey colour of the leaves; this colour is due to the fungus itself as there is, in the early stages, no discoloration of the host tissues. The leaves die prematurely. The colonies eventually become black and the short conidiophores form a close

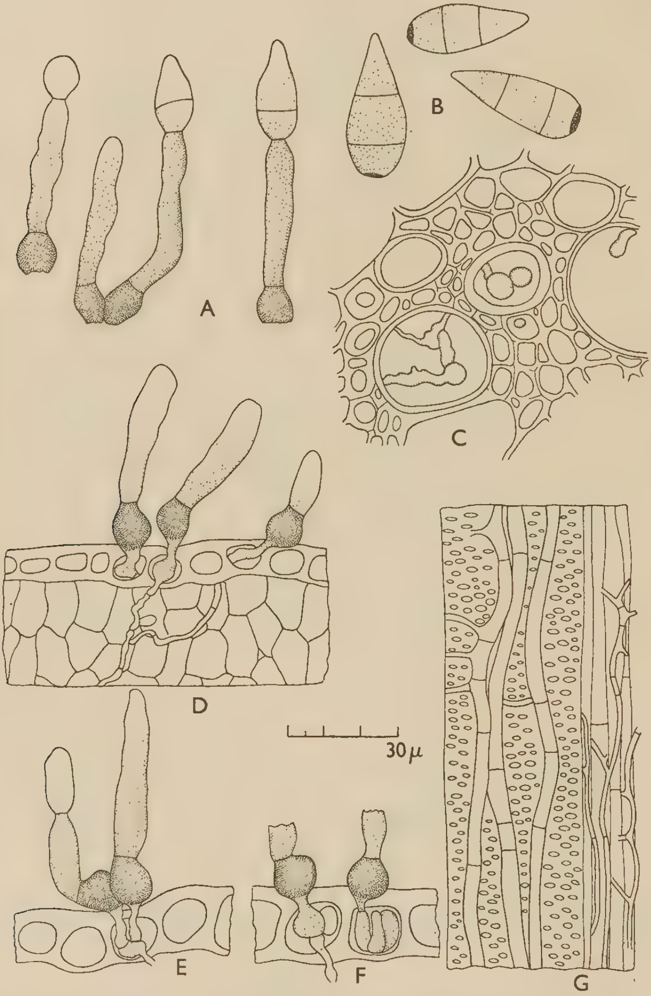

Fig. 5. *Napicladium arundinaceum.* A, conidiophores; B, conidia; C, transverse section through a vascular bundle showing thick hyphae in the vessels; D–F, sections of leaves, showing mycelium and the origin of the conidiophores; G, longitudinal section through a vascular bundle showing hyphae in the vessels.

mat covering practically the whole surface of the leaf. Mycelium (Fig. 5 C, D and G) is present in most tissues. In the epidermal cells the hyphae swell (Fig. 5 D–F); short branches, one or two from each swollen cell, grow through the outer epidermal wall and the cuticle to form conidiophores. The hyphae are mostly hyaline but are pale brown in the epidermal cells; they are smooth, 1–7 μ in diameter with cells 5–40 μ long. There is often no septum cutting off the swollen part of the mycelium inside the epidermal cell from the swollen basal cell of the conidiophore; these are joined by a narrow isthmus which passes through the epidermal wall and the cuticle (Fig. 5 D–F). The swollen cells in the epidermis are pale brown, smooth-walled, 8–12 μ long and 3–10 μ in diameter. The conidiophores (Fig. 5 A) are formed singly or in pairs from swollen cells. They are almost cylindrical, unbranched, straight or slightly flexuous, with a swollen base, and narrow slightly to the truncate apex; they are smooth-walled, the upper part is hyaline or pale brown, the lower part mid or dark brown. Length 39–58 (49) μ; diameter at apex 3–5 (3·9) μ, at the base 10–12 (11) μ, immediately above the swollen base 5–9 (6·5) μ; with usually one septum cutting off the short basal cell though occasionally a second septum is formed. The conidia (Fig. 5 B) are formed, one at a time, at the apex of the conidiophore. Mature conidia are nearly conical, narrow and rounded at the apex, rounded or flattened and with a distinct scar at the base, hyaline to brown and smooth-walled. Length 20–46 (35) μ; diameter at the apex 2–4 (3·4) μ, in the broadest part 12–17 (14) μ, at the scar or flattened base 4–8 (5) μ; with one or two septa. Material kept in a damp chamber for five days formed conidiophores up to 90 μ long; in many cases this was due to the conidiophores growing on, through the first-formed conidial scar, to form conidia at a higher level. Conidia do not germinate readily in tap water; after 4 days a few conidia germinated at the apex, each one forming a single germ tube. The germ tubes were hyaline, branched, septate, up to 200 μ long, 3·5–5 μ in diameter at the base and tapered to 1–3 μ at the apex. The fungus failed to grow on potato-dextrose and maize meal agars.

(4) **Passalora depressa** (Berk. & Br.) von Höhnel in *Zbl. Bakt.* Abt. 2, **60**, nos. 1–6, 2 (1923).

Cladosporium depressum Berk. & Br. in *Ann. Mag. nat. Hist.* **2**, no. 7, 99 (1851).
Fusicladium depressum (Berk. & Br.) Sacc. in *Fungi Ital.* t. 783 (1881).

This fungus grows parasitically on the leaves of *Angelica sylvestris*, and is widely distributed on this host plant in Great Britain; abroad it has also been reported on other members of the Umbelliferae. Conidiophores are formed in small tufts on the lower surface of the leaf on dark olive to brown, angular spots which are 1–4 mm. long; the spots often coalesce and after a time the whole of the rest of the leaf turns yellow. The mycelium (Fig. 6 D, G) consists of hyphae which penetrate freely through the tissues of the leaf and are not localized or restricted to any one layer. The hyphae are hyaline to pale olive, smooth, 1–5 μ in diameter, with cells 9–38 μ long. Below stomata the mycelium thickens and forms hyphal knots or pseudostromata (Fig. 6 E), which are olive to pale brown in colour and up to 120 μ in diameter; the cells are 4–8 μ wide and 4–14 μ long. The conidiophores

(Fig. 6E) originate from the hyphal knots and pass out through the stomata, widening the gap as more and more conidiophores are formed; groups of as many as 80 are found. They are unbranched, straight or flexuous, almost cylindrical, often swollen at the base and again a little way below the apex, olive to pale brown, smooth-walled; length 34–92 (67·8) μ;

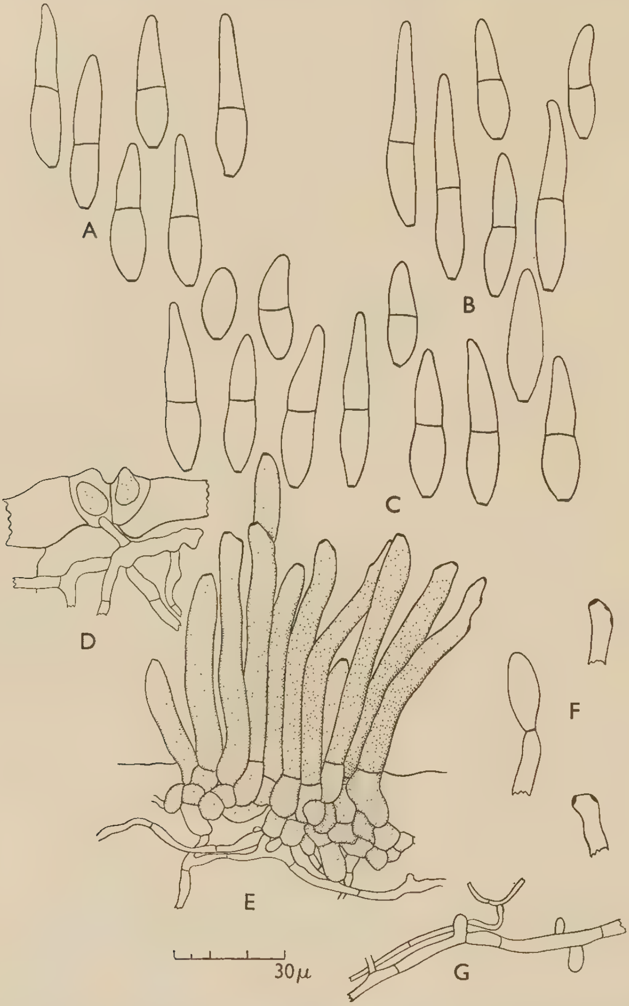

Fig. 6. *Passalora depressa.* A, B and C, conidia from three different collections; D, mycelium below a stoma; E, pseudostroma with group of conidiophores; F, tips of conidiophores showing conidial scars and one young conidium attached; G, mycelium.

diameter at the apex 2–6 (3·9) μ, at the base 6–10 (7·4) μ; with one septum near the base. On the young conidiophore a single conidium is formed at the apex; the conidiophore then grows on a short way, pushing the conidium to one side. Conidial formation is more easily studied in culture where the distance between each spore is greater than on natural substrata. Preparations usually show only one conidium attached, at the apex; the position of earlier formed conidia is indicated by two to five well-defined scars (Fig. 6F). The conidia (Fig. 6B, C) are almost obclavate, narrow at the apex and with a conico-truncate base; they are 1-septate and often slightly constricted at the septum, hyaline to pale olive, olive in mass, smooth-walled. Length 28–47 (39) μ; diameter at the apex 1·5–3·5 (2·4) μ, in the widest part 8–11 (9·3) μ, at the scar 1·5–3 (2·2) μ. Conidia from a collection authentic for the name *Cladosporium depressum* Berk. & Br. are figured (Fig. 6A). A culture of the fungus grown on malt-extract agar from 14 June to 10 August 1948 formed colonies which were white to grey, darker at the periphery, somewhat raised to form a dense cottony mat

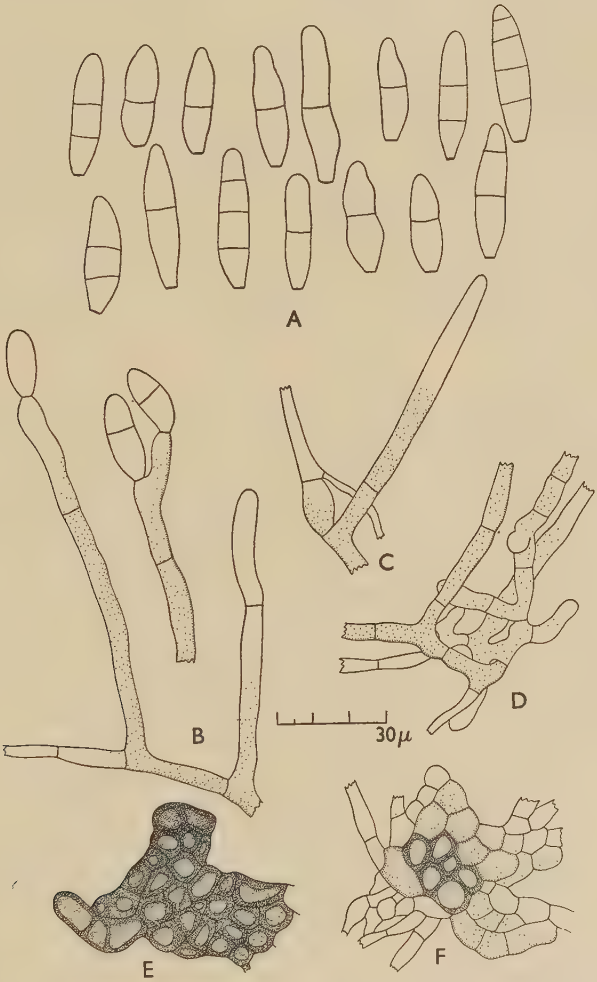

Fig. 7. *Passalora depressa* in culture on malt-extract agar. A, conidia; B, C, conidiophores; D, mycelium; E, F, sclerotia.

14 mm. in diameter, dark brown in reverse. The mycelium, which was partly superficial and partly embedded in the substratum, was composed of hyaline to brown, smooth-walled hyphae 1–5 μ in diameter, with occasional short, swollen cells up to 10 μ in diameter, the cells were from 10 to 65 μ long (Fig. 7D). The embedded hyphae tend to be dark and they readily form sclerotia (Fig. 7E, F). Separate sclerotia were 150–600 μ in diameter but they often fused to form much larger blocks; the cells were 5–12 μ in diameter and the cell walls 1–3 μ thick. The conidiophores (Fig. 7B, C), which arose singly on branches of the superficial mycelium and were scarcely distinguishable from them morphologically, were almost cylindrical, straight or flexuous, occasionally geniculate, unbranched, narrow at the base, often slightly swollen below the apex but tapering again rather abruptly to the scar, pale brown, smooth-walled; length 60–130 (92) μ; diameter just below the apical scar 4–7 (5·7) μ, at the base 4–6 (4·9) μ; with 0–2 septa. The conidia formed in culture (Fig. 7A) were sometimes obclavate but were often almost cylindrical and conico-truncate at the base; length 26–42 (35) μ; diameter at the apex 2–5 (3·4) μ, in the widest part 8–10 (8·8) μ, at the base 2–4·5 (3·3) μ; with 1–3 septa.

(5) **Dendryphiella interseminata** (Berk. & Rav.) Bubák & Ranojević in *Ann. mycol., Berl.*, **12**, 417 (1914).

Helminthosporium interseminatum Berk. & Rav. *apud* Berk. in *Grevillea*, **3**, 103 (1875).

Dendryphiella interseminata grows on the lower parts of dead standing herbaceous stems and on old stems lying on the ground; recent collections have been made, mostly from June to September, on *Heracleum sphondylium*, *Oenanthe crocata* and *Urtica dioica*. The fungus was first collected in Great Britain by F. Currey in 1855 and his specimen, labelled *Helminthosporium triseptatum*, is in the *Cladotrichum uniseptatum* folder at Herb. R.B.G. Kew. It was recorded, erroneously, from the soil by Miss E. Dale (1912). Of eighteen collections made between 1939 and 1949 twelve were from the Channel Islands, five from Surrey and one from Devonshire. The following description is based on a collection made on dead stems of *Oenanthe crocata*. The fungus forms rust-coloured to black, velvety colonies which are very variable in size and shape, some being only 1 by 0·3 cm., others spreading half-way round the stem and extending along it for 4–5 cm. The mycelium (Fig. 8F, H and I) is embedded in the substratum; it is abundant in the cells of the epidermis and cortex and strands pass down between the vascular bundles. The hyphae are hyaline to pale brown, with smooth to verruculose walls, 1·5–3 μ in diameter, with cells 11–32 μ long; in the epidermal cells, or in the cortex where these have been stripped off, the hyphae are always thicker and darker than those which are more deeply embedded. Hyphae at the point of origin of the conidiophores are pale brown to brown, 3·5–7 μ in diameter, with cells 6–40 μ long; they do not form stromata. The conidiophores (Fig. 8J) arise from branches of the mycelium which lie just below the surface of the substratum; a short branch passes through the outer cell wall, swells and gives rise directly to a conidiophore. Conidiophores are formed singly but close together. The stipe is upright, cylindrical, flexuous, branched, usually geniculate, with a number of swellings along its length and is often wollen at the base and at the apex, the rounded apical region bearing one r several conidia; it is reddish brown, paler at the apex than at the base, erruculose above the middle, smooth to verruculose below and sometimes rominently warted at the base. The branches are alternate, widely spaced, sually formed at points where the stipe is swollen. A young developing

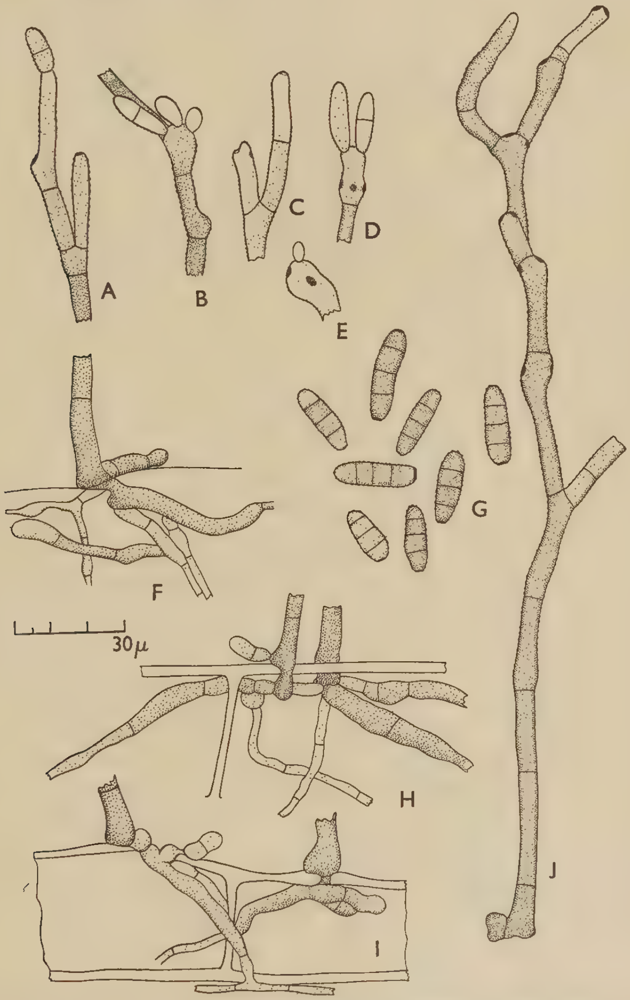

Fig. 8. *Dendryphiella interseminata*. A–E, branches and young conidia at apex of conidiophores; F, H and I, mycelium at base of conidiophores; G, conidia; J, conidiophore.

conidiophore becomes swollen at its apex where one or more conidia are formed (Fig. 8D, E); buds arise on one or both sides and one bud grows on as the main axis (Fig. 8B), the second, when present, forms a short primary branch (Fig. 8A, C) which may bear secondary branches. Length 210–300 (263) μ; diameter at the apex 4–8 (6) μ, at the base 6–10 (7·5) μ, immediately above the base 4–6 (5) μ, at the intercalary swellings 6–11 (7·9) μ;

with 4–10 septa and 0–3 primary branches. The branches (Fig. 8A, C and J) are curved, cylindrical, usually swollen at the apex and have one or more swellings along their length; they are reddish brown, pale at the tip, verruculose, 24–110 (59) μ long and 4–5 (4·5) μ thick, the proximal cells are 11–32 (21·6) μ long. The conidia (Fig. 8G) are borne at the apex and on the intercalary swellings or nodes, either singly or in groups of 2–6; they are often formed in short chains. They are cylindrical to almost clavate, septate and sometimes slightly constricted at the septa, rounded at the apex, somewhat flattened at the base, pale brown to burnt sienna, darker at the scar, smooth when young, becoming verruculose when mature; length 16–25 (21) μ; diameter at the apex 4–6 (4·7) μ, in the widest part 6–8 (6·7) μ, at the basal scar 2·5–4 (3·3) μ; with 3 septa. Conidia germinate readily in tap water forming germ tubes from the end cells (Fig. 9H); occasionally

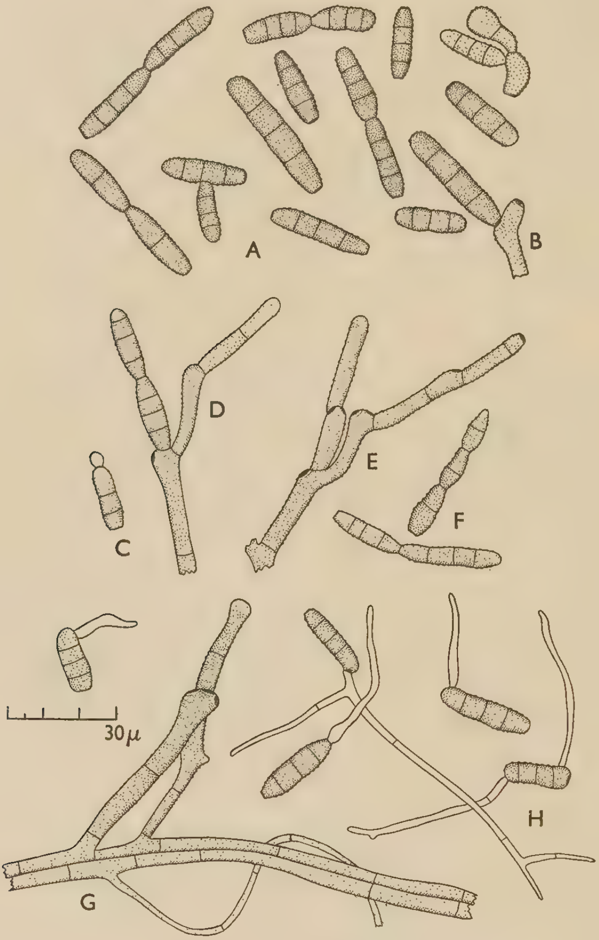

Fig. 9. *Dendryphiella interseminata*. A–G, in culture on potato-dextrose agar; H, germinating conidia.

a germ tube is formed from one of the middle cells. Germ tubes produced in 24 hr. were 20–400 μ long, 1–3 μ in diameter, hyaline, septate, smooth-walled, and bore up to four branches. *Dendryphiella interseminata*, when grown on potato-dextrose agar for 14 days at room temperature in July 1948, formed dark brown colonies 30 mm. in diameter. The mycelium, which was partly superficial and partly embedded in the agar, was composed of hyaline to pale brown, smooth to verruculose walled hyphae 1–3 μ in diameter, with cells 8–38 μ long. Hyphae at the point of origin of the conidiophores (Fig. 9G) were pale brown, 3–5 μ in diameter with cells 16–39 μ long. The conidiophores were similar to those formed on natural substrata but were usually narrow at the base, widening upwards, and often branched just above the base. Stipe length 180–450 (277) μ; diameter at the apex 4–6 (4·7) μ, at the base 2·5–4 (3·2) μ, at the nodes 5–11 (6·8) μ; with 6–14 septa and 0–4 branches; branches 41–250 (112) μ long, 4–5 (4·4) μ wide. Conidia (Fig. 9A, F) similar to those formed on natural substrata; length 17–39 (26) μ; diameter at the apex 2–5 (3·3) μ, in the broadest part 4–8 (5·9) μ, at the base 2–4 (2·9) μ; with 3 septa.

(6) **Triposporium elegans** Corda in *Icon. Fung.* **1**, 16 (1837).

This fungus occurs commonly throughout the year on dead wood and herbaceous stems; it is sometimes found on marsh and fen plants, and the following description is based on a collection made at Wheatfen Broad on dead stems of *Filipendula ulmaria*. *Triposporium elegans* is sometimes found on grey or purple areas, but often there is no discoloration of the substratum. In young colonies the conidiophores are widely spaced; in older ones they are closely packed together to form black, velvety patches which often surround a stem and extend along it for up to 10 cm. The mycelium (Fig. 10Q) is nearly all embedded in the substratum, although a few branches are sometimes found on the surface around the base of a conidiophore. The hyphae are hyaline, smooth, and they often have ganglion-like swellings; they are 0·5–1·5 μ in diameter with thickened parts up to 3 μ. Septa are not well defined, but cells 10–15 μ long have been seen. The mycelium at the point of origin of the conidiophores is brown, smooth-walled and 2·5–7 μ in diameter. The conidiophores (Fig. 10R, S and U) arise singly; their flat, thickened bases are linked by numerous strands with hyphae embedded in the substratum (Fig. 10Q, R and U), and many of these strands appear to be rooting hyphae. The stipe is almost cylindrical, unbranched, straight or slightly flexuous, smooth-walled, brown, thickened at the base to form a flat plate, narrowed towards the apex and terminates in a conidium or a scar; the scar is usually formed at the point of fracture of a short stalk cell which is carried away with the conidium. Growth usually continues after a conidium has been shed and the conidiophore swells above the first scar then narrows again (Fig. 10S). Length 94–230 (135) μ; diameter at the apex 2·5–5 (3·5) μ, at the base 12–30 (18) μ, immediately above the basal plate 5–8 (6·6) μ; with 6–14 septa. The conidia (Fig. 10H) are formed singly at the apex of the conidiophore. They are stellate, with three or occasionally four conical arms joined by their wide, rounded bases. The arms are dark brown near the centre of the spore, hyaline or subhyaline at their tips, smooth-walled, septate, with 3–6 septa, and often constricted slightly at the septa, 3–5 (3·5) μ in diameter at the tip and 9–12 (10·3) μ in diameter at the base; the greatest distance between the tips is 28–57 (43) μ. Conidia germinate slowly in tap water forming short narrow germ tubes

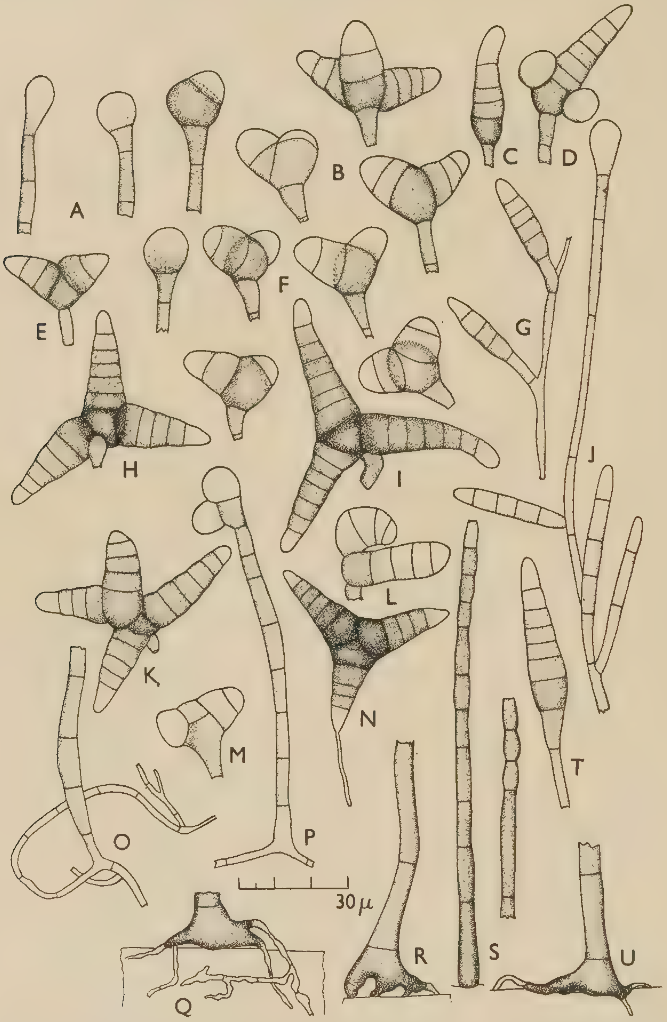

Fig. 10. *Triposporium elegans*. N, germinating conidium; H, Q–S and U, on dead stems of *Filipendula ulmaria*; all the others from a culture on oatmeal agar. A, B, E, F and M, development of conidia; C, D, G, J, K, L and T, abnormal conidia; H, I, mature normal conidia; O, Q, R and U, mycelium and bases of conidiophores; P, S, conidiophores.

at the tips of the arms (Fig. 10N); after 72 hr. germ tubes were up to 20 μ long and 1–2 μ in diameter. Conidia were seeded on to malt agar on 15 April 1948, growth was slow and white colonies only 5 mm. in diameter were formed by 29 April; these were transferred to oatmeal agar where they expanded to 25 mm. by 25 May. The colonies were dark brown, with a short mat of conidiophores, paler at the edge, zonate in reverse with grey, brown and black concentric rings, pale at the centre and at the periphery. The mycelium (Fig. 10 O) was composed of hyaline, smooth-walled hyphae, 1–3 μ in diameter with cells 10–25 μ long; it was partly superficial and partly embedded in the substratum. Hyphae at the point of origin of the conidiophores (Fig. 10 O, P) were pale brown, 2–4 μ in diameter with cells 15–30 μ long. The conidiophores (Fig. 10 P), formed as lateral branches on the mycelium, were straight or flexuous, narrow at the apex and at the base, smooth-walled, pale brown near the apex, brown below, not branched; length 30–160 (84) μ; diameter at the apex 2·5–4 (3·5) μ, at the base 2–7 (3·6) μ; with 2–7 septa. Most of the conidia closely resembled those formed on natural substrata (Fig. 10 I); the arms were 3–5 (3·9) μ in diameter at the tip, 9–12 (10·2) μ in diameter at the base, with 3–6 septa; the greatest distance between the tips was 29–70 (49) μ. Fig. 10 A, B, E, F and M show the development of the conidia. From a swollen cell at the apex of the conidiophore an obliquely lateral protuberance develops, and this is cut off by a septum; a second and occasionally a third protuberance is formed in the same way and the original inflated cell grows on to form either the third or the fourth arm of the conidium. As the arms grow outwards, diverging from one another, transverse septa are laid down. The arms sometimes develop unevenly resulting in the formation of a distinctly asymmetric spore (Fig. 10 D, L). Sometimes the swollen initial cell grows on without forming any lateral protuberances and a simple *Clasterosporium*-like conidium is produced (Fig. 10 C, G, J and T).

(7) **Helicosporium phragmitis** von Höhnel in *Ann. mycol., Berl.*, **3**, 338 (1905).

At Wheatfen Broad *H. phragmitis* is common on decaying culms of *Glyceria maxima* lying in the very damp basal leaf mat. This fungus is often seen on marshes and fens and it has been found in these habitats on *Arrhenatherum elatius*, *Phalaris arundinacea* and *Phragmites communis* as well as on *Glyceria maxima*. *Helicosporium phragmitis* is probably the conidial state of *Tubeufia helicomyces* von Höhnel which is very frequently found with it. The colonies are effused, somewhat raised, cottony, pale grey to pale brown, tinged with pink when sporing freely, round or oval and up to 1·5 by 0·5 cm. Hyphae (Fig. 11 F) pass freely through the dead tissues and also form a superficial mat; they are hyaline to pale brown, smooth-walled, 2–5 μ in diameter, with cells 6–34 μ long. The conidiophores (Fig. 11 D) arise as lateral branches on the mycelium and morphologically closely resemble the ordinary vegetative hyphae. They are often forked close to the base; sometimes there is a stipe with up to three branches and these branches are closely intertwined and occasionally anastomose. The stipe is sometimes erect and sometimes prostrate, cylindrical, usually flexuous with the upper part sometimes spirally twisted and tapering to the rounded apex; it is hyaline to pale brown, smooth. Length 180–370 (295) μ; diameter at the apex 2–3·5 (2·7) μ, at the base 4–5 (4·3) μ; with 11–20 septa. The branches are cylindrical, tapering towards the apex, hyaline to pale brown, smooth, 60–300 (174) μ long and 3–4 (3·5) μ in diameter at the base. The conidia

(Fig. 11 A) are attached to the sides of the conidiophores, at any level, by short smooth cylindrical pegs which are 1–8 μ long and 1 μ in diameter (Fig. 11 B, C). They are helically coiled, two to four times in one plane, hyaline, pink in mass, smooth-walled, 14–21 (18) μ in diameter; the filaments are rounded at the apex, often truncate at the base, 1·5–2·5 (2) μ thick, with 7–12 septa. Conidia germinate readily in tap water forming, in 24 hr., 1–4 hyaline germ tubes which are 12–35 μ long and 2–2·5 μ in diameter (Fig. 11 E).

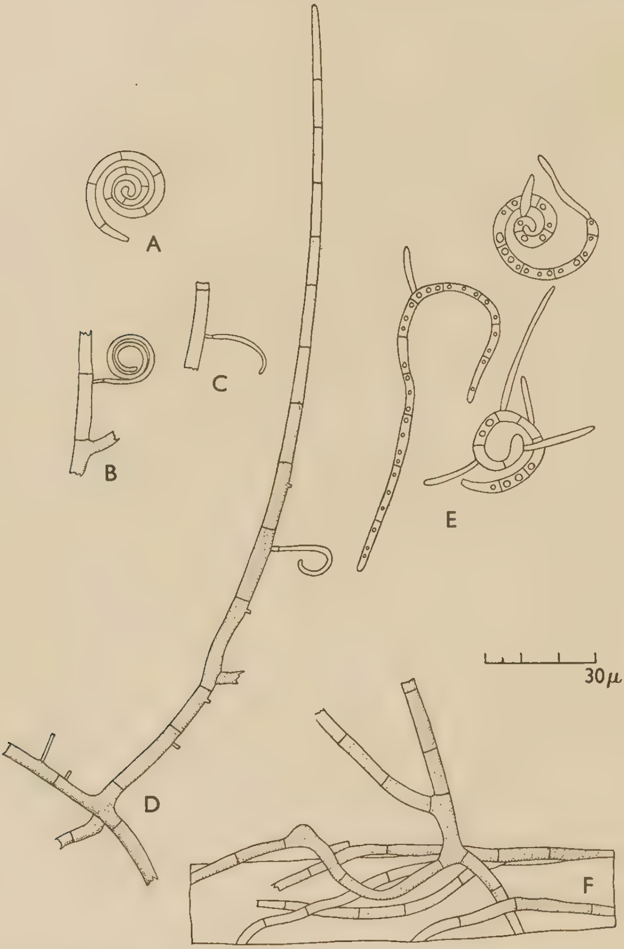

Fig. 11. *Helicosporium phragmitis.* A, conidium; B, C, young conidia attached to the side of a conidiophore by short pegs; D, conidiophore; E, germinating conidia; F, mycelium and base of conidiophore.

(8) **Speira toruloides** Corda in *Icon. Fung.* **1**, 9 (1837).

This fungus grows on dead wood, herbaceous stems and occasionally leaves, and is found throughout the year; it has been collected several times in marshes and fens on *Angelica sylvestris*, *Cladium mariscus*, *Epilobium hirsutum*, *Filipendula ulmaria* and *Juncus effusus*. The following description is based on a collection made on fallen dead stems of *Epilobium hirsutum*; the fungus causes no discoloration of the substratum. The colonies are black, effused, granular, closely pressed to the substratum, variable in size, sometimes less than 1 mm. in diameter and sometimes almost surrounding the stem and extending along it for up to 2 cm. The mycelium (Fig. 12 F) is all embedded in the stem tissues; the hyphae are hyaline to pale brown, smooth-walled, 2–5 μ in diameter, with cells 5–10 μ long. There are no true conidiophores and the conidia are borne singly at the ends of branches of the mycelium where these break through to the surface. Each conidium is, as a rule, subtended by a hyaline, swollen cell. The conidia (Fig. 12 A–C and E–F) are flattened in one plane and composed of 6–8 rows of cells which are of unequal length, the middle ones being longer than those at each side. The rows of cells develop as a branched system. Each conidium is shaped rather like a hand with the fingers held close together. The cells are smooth-walled and mostly olive to brown, although the end ones in each row are often hyaline. Length of the longest row 38–45 (42·4) μ; diameter of conidium in its widest part 25–34 (29) μ, of the middle cell of the outer row 5–7 (5·8) μ, of the hyaline cell at the base 4–9 (5·8) μ; total number of cells 36–51. The conidia germinate slowly in tap water forming a single germ tube from the basal cell. Fig. 12 D shows two conidia after 84 hr. in tap water.

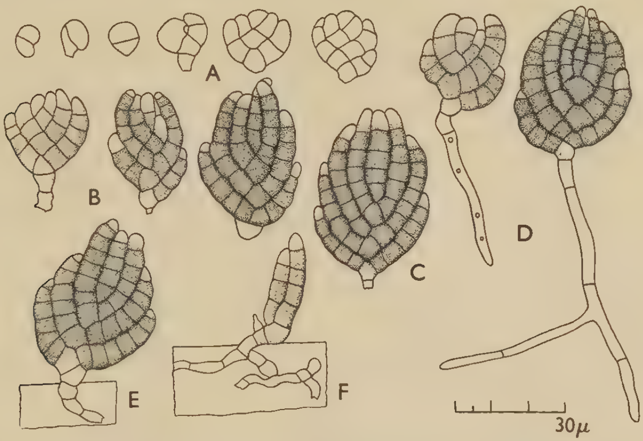

Fig. 12. *Speira toruloides.* A, B, young conidia; C, E, mature conidia; D, germinating conidia; F, mycelium with conidium attached.

(9) **Stachylidium bicolor** Link *ex* Fr.: Link in *Mag. Ges. Naturf. Freunde, Berl.*, **3**, 13 (1809); Fries in *Systema Mycol.* **3**, 391 (1832).

S. bicolor has been collected, usually in the autumn, on dead stems of *Heracleum sphondylium*, *Oenanthe crocata*, *Petasites hybridus*, *Pteridium aquilinum* and *Urtica dioica*, and is seen occasionally on dead fallen branches of trees.

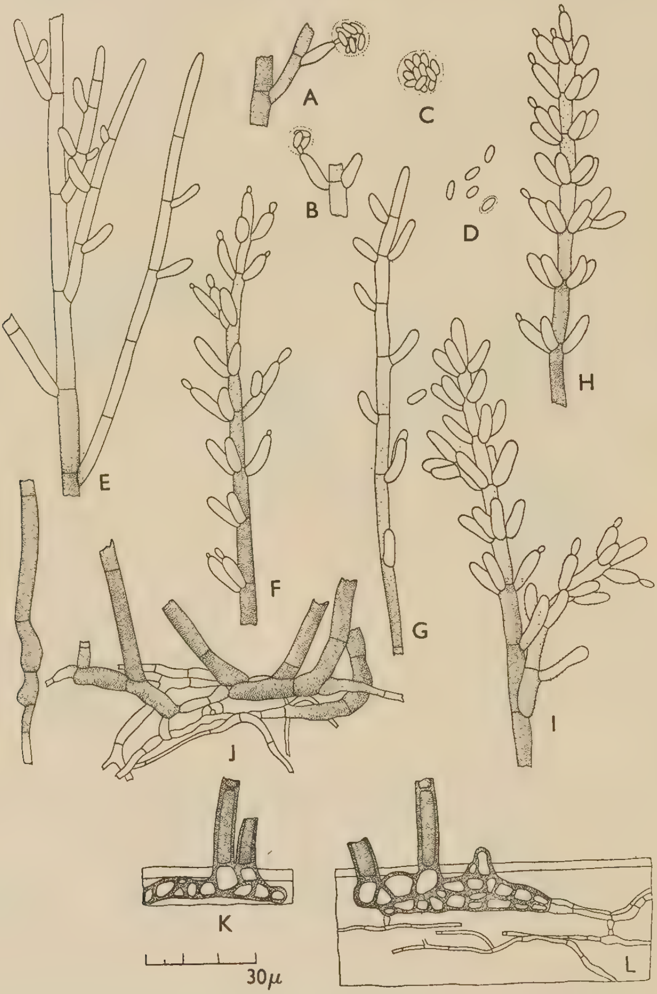

Fig. 13. *Stachylidium bicolor.* A–D, I, K and L, on dead stems of *Oenanthe crocata*; E–H and J, in culture on potato-dextrose agar. A, B, conidia developing at apex of phialide; C, ball of conidia adhering to one another by their mucilaginous sheaths; D, conidia; E–I, parts of conidiophores showing branches and phialides; J, mycelium at base of conidiophores; K, L, stromata.

It has been found several times in marshy places. The following description is based on a collection of the fungus made on dead stems of *Oenanthe crocata*. The colonies are grey to olive, furry, often effused, up to 10 by

4 cm., irregular in outline. The mycelium (Fig. 13L), which is mostly embedded in the cortex, is composed of hyaline, smooth-walled hyphae 1–3 μ in diameter with cells 3–18 μ long; small stromata are formed at the point of origin of the conidiophores. The stromata (Fig. 13K, L) are embedded in the substratum; they are flattened dorso-ventrally, oval or irregular in outline, olive to brown, 30–150 μ long, 6–18 μ high; the cells are 3–10 μ in diameter with walls 1–2 μ thick. The conidiophores (Fig. 13I) arise sometimes singly but usually in groups of 2–30. The stipe is straight or flexuous, tapering towards the rounded apex, sometimes distinctly swollen at the base, hyaline to pale olive above the middle, olive to brown below, smooth to minutely verrucose, simple or branched; length 230–540 (389) μ; diameter at the apex 2·5–4 (3·4) μ, at the base 4–7 (5·3) μ; with 13–23 septa and 0–6 whorls of primary branches. The primary branches arise immediately below septa, either singly, in pairs or in verticils; secondary branches are sometimes formed. The primary and secondary branches and the upper part of the stipe bear numerous phialides and these arise below septa either singly, in pairs or in verticils. The branches are cylindrical and taper gradually towards the rounded apex and usually lie at an acute angle to the stipe; they are hyaline at the tips, olive at the base, smooth or minutely verrucose, 18–220 (122) μ long and 3–5 (3·8) μ in diameter at the base. The conidia (Fig. 13D) are formed, one at a time, at the tips of the phialides (Fig. 13B). Each conidium, on emergence, is surrounded by a mucilaginous sheath and adheres to its fellows to form a spherical mass (Fig. 13A, C), 6–24 μ in diameter, at the end of the phialide. Warming in lactic acid tends to disperse the conidia so that often only the last-formed conidium is seen *in situ*. Conidia are cylindrical with rounded ends or narrowly oval, hyaline, pale olive in mass, smooth-walled, 4–6 (4·9) μ long and 2–2·5 (2·1) μ thick. The phialides are oval to cylindrical, rounded at the apex, hyaline, smooth or minutely verrucose, 9–17 (12·3) μ long and 3–4 (3·6) μ in diameter. The fungus was grown on potato-dextrose agar from 22 December 1948 to 19 January 1949. It formed colonies up to 16 mm. in diameter which were white, grey where sporulating, raised and somewhat tufted, dark brown with a buff surround in reverse. The mycelium, which was partly superficial and partly embedded in the substratum, was composed of hyaline to very pale brown hyphae 1–3 μ in diameter, with cells 6–21 μ long. The mycelium at the point of origin of the conidiophores (Fig. 13J) was pale olive to brown and composed of smooth-walled hyphae 3–6 μ in diameter with cells 6–18 μ long; the thickened hyphae tended to run parallel to one another and sometimes anastomosed. The conidiophores (Fig. 13E–H) arose singly but were usually clustered together, and in general form they resembled those formed on natural substrata. Length of stipe 410–800 (628) μ; diameter at the apex 2·5–4 (3·3) μ, at the base 4–6 (4·9) μ; with 12–30 septa and 0–10 whorls of primary branches. The branches (Fig. 13E) were 22–170 (69) μ long and 3–4 (3·2) μ in diameter at the base. The conidia were 4–6 (5) μ long and 2–2·5 (2·1) μ in diameter and the phialides 10–15 (12·3) μ long and 3–4 (3·6) μ in diameter.

(10) **Sporoschisma mirabile** Berk. & Br. *apud* Berk. in *Gdnrs' Chron.* p. 540 (1847).

This fungus is most commonly found on rotten wood; it is found occasionally, however, on herbaceous stems, and the following description is based on a specimen collected on *Epilobium hirsutum* at Wheatfen Broad. The black, hairy groups of conidiophores are rather widely spaced to form colonies 1–3 sq.cm. in area. There is no superficial mycelium; embedde hyphae are hyaline to pale brown, smooth-walled, mostly 1·5–3 μ in dia meter but swelling up to 7 μ at the base of the stroma, with cells 8–25 μ long Stroma (Fig. 14D) sometimes superficial but usually at least partly em bedded in the substratum, very dark brown, 30–80 μ long, 25–50 μ wid

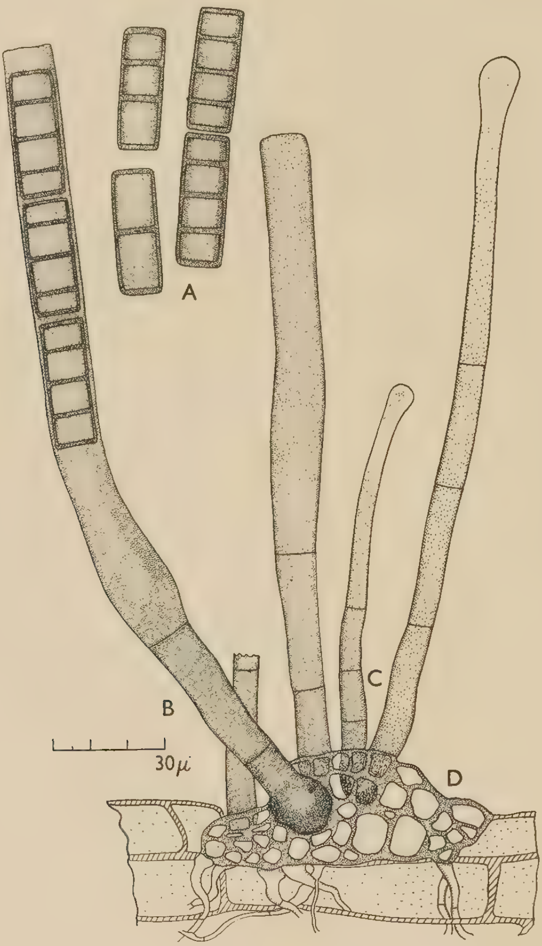

Fig. 14. *Sporoschisma mirabile.* A, conidia; B, conidiophores; C, capitate hyphae; D, stroma.

and 14–30 μ high; diameter of cells 5–18 μ; thickness of cell walls 1–3 μ. The conidiophores (Fig. 14B) arise from a stroma and are interspersed by sterile capitate hyphae; the stromata in this collection were small and each stroma bore 1–4 conidiophores and 1–7 capitate hyphae. Each conidiophore consists of a simple, septate stipe ending in a long, inflated spore sac. The stipe is straight or slightly curved, often swollen at the base, expanded at the apex, simple, mid-brown to very dark brown, smooth-walled; length 42–70 (62) μ; diameter immediately below the spore sac 10–12 (10·9) μ, at the base 11–20 (14) μ, immediately above the swollen base 8–10 (8·7) μ; with 0–2 septa. Spore sac cylindrical, straight, smooth, brown to dark brown; length 110–210 (158) μ; diameter at the apex 12–14 (13) μ, in its broadest part 14–19 (15·5) μ. The conidia (Fig. 14A) are formed in basipetal succession from a thick column of protoplasm inside the spore sac where up to three conidia can be seen at a time; they issue in long chains and tend to hang together for a time. They are cylindrical, brown, smooth-walled, 26–36 (33) μ long, 10–13 (11·7) μ in diameter, with 0–3 septa. The capitate hyphae (Fig. 14C) are straight or somewhat flexuous, swollen into a knob at the apex and sometimes slightly inflated at the base, the upper part is hyaline to pale brown and the lower part brown. The swollen apical part is usually thin-walled and the stipe sometimes grows on through this and forms another swelling at a higher level; length 97–185 (144) μ; diameter of knob 6–10 (7·4) μ, in the middle 3–6 (4·3) μ, at the base 6–12 (8·5) μ; with 2–4 septa.

REFERENCES

Corner, E. J. H. (1935). The fungi of Wicken Fen, Cambridgeshire. *Trans. Brit. mycol. Soc.* **19**, 280–287.

Dale, E. (1912). On the fungi of the soil. *Ann. mycol., Berl.*, **10**, 469–470.

Ellis, E. A. (1941). The natural history of Wheatfen Broad, Surlingham, Part 3. *Trans. Norfolk Norw. Nat. Soc.* **15**, 191–219.

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PODOCHYTRIUM CORNUTUM N.SP., THE CAUSE OF AN EPIDEMIC ON THE PLANKTONIC DIATOM *STEPHANODISCUS*[*]

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(With 1 Text-figure)

A new species of the chytrids, *Podochytrium cornutum*, has been found to be the cause of a serious epidemic among populations of the planktonic diatom *Stephanodiscus niagarae* from Lake Mendota, Madison, Wisconsin, U.S.A. A description of the causal agent and a discussion of the differences between it and the other two species of the genus, *Podochytrium clavatum* and *P. lanceolatum*, are included.

Chytrids are known to cause epidemics among populations of various green algae. Indeed, the reports of such depredations are found in some of the earliest papers on these fungi. Information on them as destroyers of important planktonic algae is, however, as yet meagre. In view of the significance of such algae in the economy of fresh waters it is of considerable interest to record instances of their destruction by extraneous organisms. The publication of such data is also important in that it brings to the attention of limnologist and oceanographers the fact that fungi can be very potent agencies in the destruction of populations of phytoplankton.

The latest and most extensive work in this phase of mycology has been carried on by Canter (1946, 1949), and Canter and Lund (1948) in the English Lake District. These investigators have shown that not only are common pelagic algae attacked on a significant scale by phycomycetous fungi, but that the important planktonic diatom *Asterionella* is subject at certain seasons of the year to severe epidemics caused by the chytrid, *Rhizophidium planktonicum*. A review of previous publications on epidemics among planktonic algae is given in the paper by Canter and Lund.

It is the purpose of this note to call attention to another instance of severe parasitism of a planktonic diatom by a chytrid. In January 1950, an examination of plankton from Lake Mendota, Madison, Wisc., by Dr H. M. Clarke revealed that the diatom *Stephanodiscus niagarae*, present in large numbers, was parasitized by a chytrid. A generous preserved sample of this material was sent to me for identification by Dr Myron P. Backus.[†] Since the sample submitted was a concentrated one, no data on the actual number of parasitized and healthy diatoms per ml. could be obtained. Some idea of the intensity of the epidemic was easily gained, however, from the fact that many random samples of the concentrate of approximately the same volume frequently yielded populations almost completely devoid of uninfected diatoms. In some instances the margin of the valve, apparently the most vulnerable region of the host, bore 50–60 or more fungus thalli in varying stages of development. Total destruction of the diatom resulted from even a single infection. As might be expected, host cells attacked by many parasites were stunted in comparison with cells with only a few parasites. In the process of destruction the rather coarse rhizoidal system ramified freely throughout the cell causing fragmentation of the conspicuous chloroplasts and eventual total disappearance of the cell contents.

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[*] Contribution No. 922 from the Department of Botany, University of Michigan.

[†] The author wishes to express his thanks to Prof. Clarke and Prof. Backus for the opportunity of observing this material.

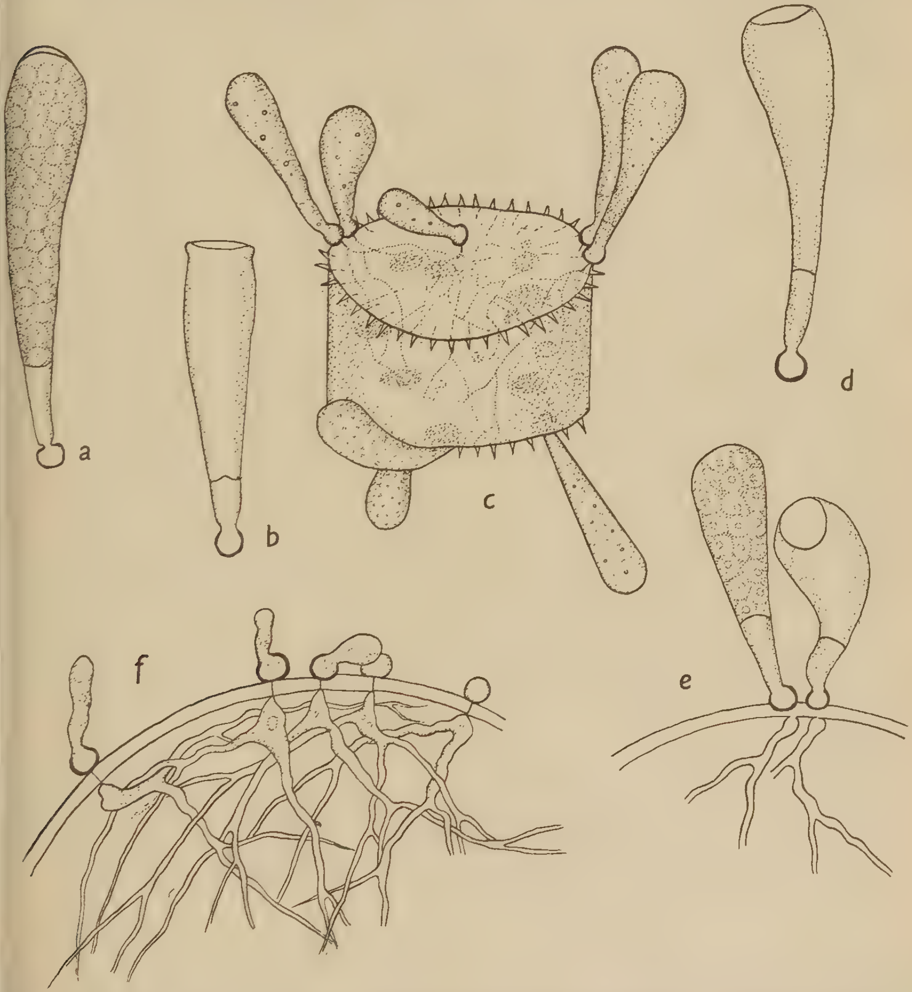

Fig. 1. *a*, *b*, *d–f*, ×980; *c*, ×660. *a*, sporangium with mature zoospores; *b*, empty sporangium; *c*, diatom attacked by eight parasites; *d*, empty sporangium; *e*, mature and empty sporangia on frustule of host; *f*, portion of frustule bearing very young thalli.

The parasite involved was clearly a species of *Podochytrium*, a small genus of diatom-attacking Phycomycetes which possesses a highly characteristic sterile basal portion to the epibiotic sporangium. A further peculiarity is the manner in which the rudiment of the sporangium develops. Rather than the whole body of the encysted zoospore enlarging to form the reproductive structure, as in *Rhizophidium*, the basal portion remains unenlarged and from it there emerges, distally, an outgrowth which becomes differentiated into the sterile and sporogenous parts (Fig. 1 *c*, *f*). In the present fungus, the zoospore after encystment on the surface of the diatom frustule produced a delicate penetration tube from the tip of which there was formed within the host a coarse, irregular and richly branched rhizoidal system (Fig. 1 *f*). Very frequently a somewhat triangular plexus developed at the point of origin of the primary axes of the rhizodial system. From the various developmental stages present in the material it was evident that the basal sterile part was cut off after the clavate sporangium had reached maturity. Whether or not the rhizoidal system had previously been cut off at the base of the cyst, as seemed likely, could not be determined.

Mature zoospores, about 3–4 μ in diameter and bearing a single globule were seen in many sporangia (Fig. 1 *a*, *e*). They were unquestionably liberated through a broad apical pore, 7–9 μ in diameter. There was no evidence for the presence of an operculum. No resting spores were found.

Two species of *Podochytrium*, both parasitic on diatoms, have thus far been described. One, *P. clavatum* Pfitzer, forms short clavate or obpyriform sporangia 8–19·2 μ high by 5–8·4 μ in diameter which rests directly on a knoblike sterile basal cell 2·5–3 μ in diameter. A broad apical pore is formed for the discharge of the zoospores which are spherical, 3 μ in diameter. The rhizoids are extremely delicate and branched. *P. clavatum* has been reported on various species of diatoms. The second species, *P. lanceolatum* Sparrow, forms lanceolate or somewhat fusiform sporangia 20–25 μ high by 8–10 μ in diameter, tapering at each end to 3–4 μ and resting upon a cuplike or knoblike base 4–5 μ in diameter. A small apical pore is formed through which the spherical zoospores 3–4μ in diameter escape. The species has been reported thus far only on *Melosira varians* from England.

The present species, on *Stephanodiscus*, differs from those previously described in being narrowly clavate and in forming strikingly longer zoosporangia, which average about 45 μ in length by 11 μ in greatest distal diameter. From the resemblance of the empty sporangia to certain types of ancient horns (Fig. 1 *b*, *d*) the name *cornutum* is applied to it.

Podochytrium cornutum sp.nov.

Sporangia laevia, anguste clavata 33–58 μ, mediocriter 45 μ longitudine; 10–13 μ prope apicem crassitudine, usque ad 3–4 μ prope basem partis tenuis sterilis 10 μ longae, sedentia in corpusculum zoosporae induratae 3–4 μ diametientis. Systema rhizoidale crassum, ramosissimum, saepissime conspicue expansum prope insertionem ramorum primariorum. Zoosporae sphaericae (?) 3–4 μ dia., globula praeditae, ex orificie apicali emittentes. Sporae perdurantes hucusque ignotae.

Parasiticum et epidemicum in *Stephanodisco Niagarae* prope oppidum Madison, Wisconsin, U.S.A.

Sporangium smooth-walled, narrowly clavate, 33–58 μ (av. 45 μ) long by 10–13 μ in broadest distal portion, tapering to 3–4 μ in diameter at the base of the narrow, 10 μ long concomitant sterile part; the whole resting on the rounded 3–4 μ in diameter body of the encysted zoospore. hizoidal system coarse, much branched, usually conspicuously expanded the point of origin of the primary branches. Zoospores spherical (?), -4 μ in diameter, with a globule, escaping through a broad apical pore -10 μ in diameter. Resting spore not observed.

Parasitic in, and causing an epidemic on, *Stephanodiscus niagarae*, Madison, isc., U.S.A.

REFERENCES

ANTER, H. M. (1946). Studies on British chytrids. I. *Dangeardia mammillata* Schröder. *Trans. Brit. mycol. Soc.* **29**, 128–134.

ANTER, H. M. (1949). Studies on British chytrids. IV. *Chytriomyces tabellariae* (Schröter) n.comb., parasitized by *Septosperma anomalum* (Couch) Whiffen. *Trans. Brit. mycol. Soc.* **32**, 16–21.

ANTER, H. M. & LUND, J. W. G. (1948). Studies on plankton parasites. I. Fluctuations in the numbers of *Asterionella formosa* Hass. in relation to fungal epidemics. *New Phytol.* **47**, 238–261.

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MORPHOLOGICAL AND PHYSIOLOGICAL STUDIES ON *SORDARIA DESTRUENS* (SHEAR) COMB.NOV. (SYN. *MELANOSPORA DESTRUENS*), *SORDARIA FIMICOLA* AND *MELANOSPORA ZAMIAE*

By LILIAN E. HAWKER
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(With 5 Text-figures)

Three strains of *Melanospora destruens* were compared with three of *Sordaria fimicola* and one of *Melanospora zamiae*. The strains of *M. destruens* and *Sordaria fimicola* resemble each other in size and shape of perithecia, size and general shape of asci, and size, shape and method of germination of ascospores, but differ in shape of the tip of the ascus which is slightly flatter in *Melanospora destruens* than in *Sordaria fimicola*, and in the greater frequency of the presence of a wide gelatinous sheath surrounding the ascospores of *S. fimicola*. *Melanospora zamiae* differs from both *M. destruens* and *Sordaria fimicola* in possessing a long perithecial neck with a fringe of bristles surrounding the ostiole, pyriform evanescent asci, and spindle-shaped ascospores with two polar germ-pores and in the mode of germination.

S. fimicola shows a greater tendency to a 'staled' type of growth than does *Melanospora destruens* or *M. zamiae*. The strains of *Sordaria fimicola* and *Melanospora destruens* all show higher cardinal points for temperature than does *M. zamiae*. The reaction of *M. zamiae* to different sources of carbon and growth substances also differed from that of the *M. destruens* and *Sordaria fimicola* strains which show only minor differences among themselves.

It is suggested that *Melanospora destruens* should be transferred to *Sordaria* as *S. destruens* (Shear) Hawker, comb.nov.

Fertile strains of *Melanospora destruens* grow relatively more quickly at temperatures of 30° C. and over than do sterile strains, and incubation of new subcultures for several days at 30° C. prevents loss of fertility in culture.

During an investigation of the physiology of a strain of *Melanospora destruens* (Shear) Shear & Dodge, it was noted that this fungus showed closer morphological and physiological resemblances to certain species of *Sordaria* than to *Melanospora zamiae*, one of Corda's type species (Corda, 1837). Accordingly, a comparison was made of the morphology and physiology of strains of *Melanospora* and *Sordaria*, and the conclusion was reached that this species would be more appropriately included in *Sordaria*. The following new combination is therefore proposed: **Sordaria destruens** (Shear) Hawker, comb.nov., syn. *Anthostomella destruens* Shear (Shear, 1907, p. 313), *Melanospora destruens* (Shear) Shear & Dodge (Shear & Dodge, 1927, p. 1024).

The following strains were examined:

D (i), *Sordaria destruens* (Shear) Hawker. Originally isolated by Shear (1907) from fruits of *Vaccinium* spp. and distributed by him under the name of *Anthostomella destruens* Shear. This isolation was received at the National Collection of Type Cultures in April 1922 and was listed as 'N.C.T.C.1314: C. L. Shear No. 67 from Cranberry'; now in the Herbarium of the Commonwealth Mycological Institute, Kew, Surrey, and numbered (N.C.T.C.

314/I.M.I. 428). The type was isolated from cranberry fruit and the type
ide was No. 1419 C.L.S. from pure culture 450 (Shear, Stevens & Bain,
931); later renamed *Melanospora destruens* (Shear) Shear & Dodge (Shear
Dodge, 1927).

D (ii), *Sordaria destruens*. Isolated from apple by Dr A. S. Horne in the
lant Pathological Laboratory, Imperial College of Science and Tech-
ology, London, in 1932; identified by Mr Mason, Commonwealth
ycological Institute, Kew, as *Melanospora destruens*, used by the writer in
series of physiological studies (Asthana & Hawker, 1936; Hawker, 1936,
939 *a*, *b*, 1942, 1944, 1947 *a*, *b* and 1948); No. 429 in the Herbarium of the
ommonwealth Mycological Institute, Kew.

D (iii), *Sordaria destruens*. Isolated from horse dung by Mr T. Taylor in
e Department of Mycology and Plant Pathology, Imperial College of
cience and Technology, London, in 1936. When first isolated, young
scospores from cultures on malt agar showed mucilaginous envelopes
rolonged into a short basal tail. Older spores lacked these tails and
esembled spores of *S. destruens* D (ii). The strain was therefore identified as
species of *Podospora*. Some aspects of the physiology of this strain were
vestigated by Hawker and Chaudhuri (1946). After some years in culture
e strain ceased to produce gelatinous tails even on very young spores. It
as then submitted to Mr Mason who confirmed the writer's opinion that
was morphologically indistinguishable from *Sordaria destruens*.

M.z., *Melanospora zamiae* Corda, obtained from the Department of
otany, Victoria University of Manchester.

F (i), *Sordaria fimicola* (Rabenh.) Ces. & de Not. from the stock culture
ollection of the Imperial College of Science and Technology, London;
ncertain origin.

F (ii), *S. fimicola*, isolated by the writer from owl pellets collected by
V. G. Bramley at Bolton Percy, Yorkshire, 17 July 1945; Herb. I.M.I. No.
005; and determined as *S. fimicola* at the Commonwealth Mycological
nstitute, Kew.

F (iii). A strain of *Sordaria* of unknown origin in the stock culture col-
ection of the Department of Botany, University of Bristol; differing from
(i) and (ii) only in greater size of perithecia and considered to be a strain
f *S. fimicola*.

CULTURAL FEATURES

trains D (i), (ii) and (iii) are similar on 3% malt agar. The advancing
argins of the colonies are regular, show no evidence of staling (Brown,
923) and reach the edges of the plates in 2–3 days at 25° C. The mycelium
much branched and forms a slightly wrinkled crust over the surface of
e agar with scanty tufts of white aerial mycelium. Colour develops after
few days as a pale brown stain at the edges of the plates. Later the whole
ycelium becomes blackish brown and the agar is also stained. When
(ii) and (iii) were first isolated perithecia were formed at the margins of
e plates 7–10 days after inoculation, and at 14 days after inoculation
umerous mature perithecia were present and were most numerous to-
ards the edges of the plates. Fertility decreased progressively in culture,
nd at the present time (May 1950) only a few perithecia are formed at the

margin of the plates and on the sides of the Petri dishes. D (i) now rarely forms perithecia on malt agar. All strains produce fruit-bodies on sterilized rabbit dung. Strain F (iii), in general, resembles the strains of *Melanospora destruens* but produces numerous perithecia, which are more crowded towards the edge of the plate than on the centre, thus resembling the earlier condition of *M. destruens*.

The other strains of *Sordaria fimicola* produce colonies with some irregular growth. The margins of the colonies have a fluted appearance suggesting the staling type of growth described by Brown (1923) for *Fusarium fructigenum*. The mycelium becomes brown and scattered perithecia occur over the surface of the colony after 14 days. When first isolated F (ii) showed a non-staling type of growth similar to that of F (iii) or D (i), (ii) and (iii), but growth gradually became less vigorous until all cultures were of the irregular staling type.

Strain M.z. produces colonies of a type distinct from all the others. These are of slow growth but of the non-staling type and produce a mass of white, fluffy aerial mycelium. Perithecia develop after 10–14 days, but in contrast to D (i), (ii) and (iii), these are more numerous at the centre of the colony. Colour is not produced in either mycelium or agar.

Morphology and size of perithecia

Very young perithecia of all strains are similar and are first seen as small white spherical knots of hyphae which become oatmeal-coloured, pale brown and finally dark brown or black. Details of development were not followed.

Photographs of perithecia of *Melanospora destruens* have been published by Shear and Dodge (1927) and by Smith (1946). Perithecia of D (i), (ii) and (iii) agree well with these photographs. When just ripe the perithecia are about 360 μ in diameter (see Table 1) and have a small apical papilla. Older perithecia usually have a short tapering beak.

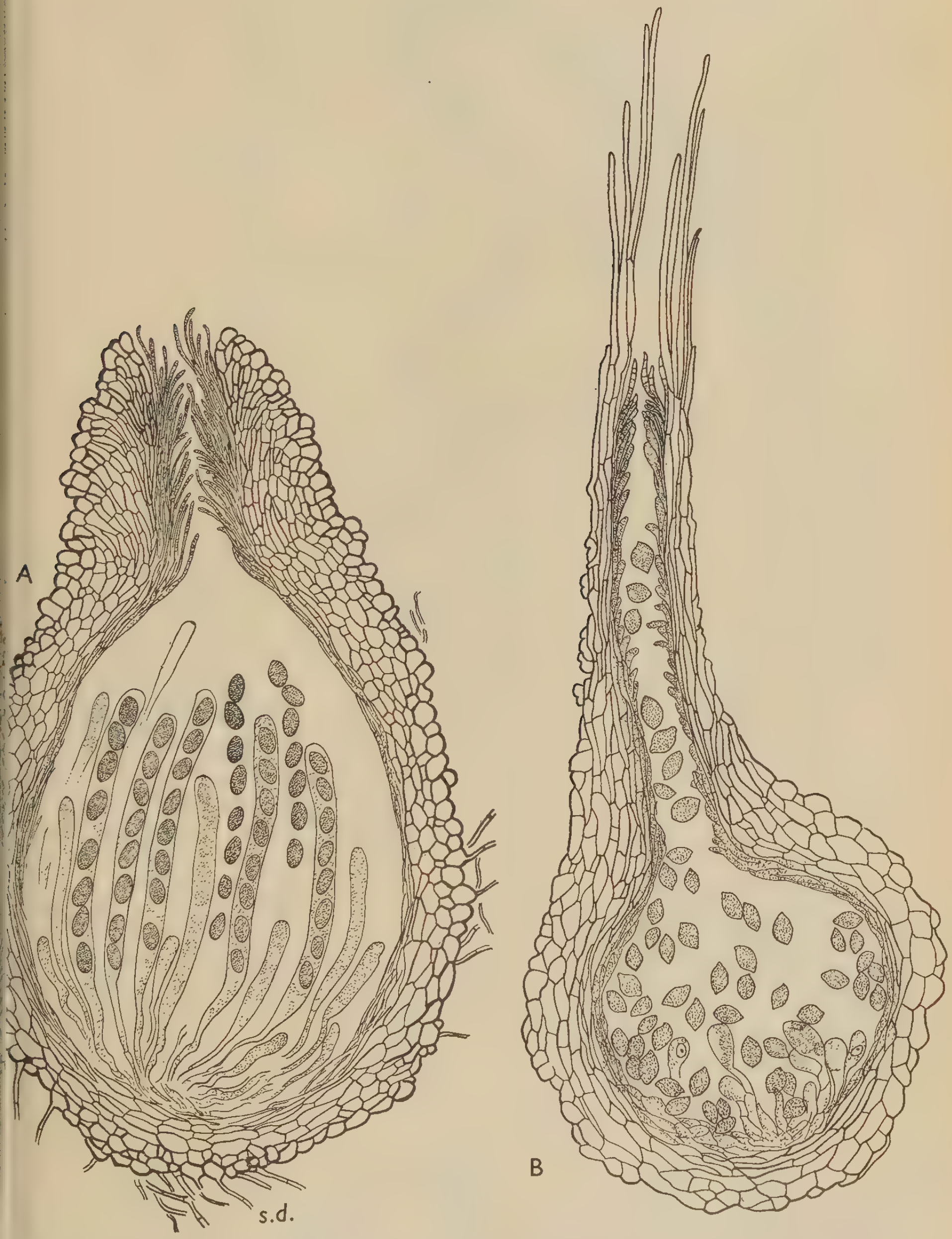
Perithecia of strains F (i), (ii) and (iii) closely resemble those of the *destruens* group in shape but are slightly larger.

Longitudinal sections of the perithecia show that the structure of the peridium, and the arrangement of the asci is similar in all the *destruens* and *fimicola* strains. The cells of the neck of the former are rather less regularly arranged and the sterile hairs of periphyses lining the neck occasionally project very slightly beyond the ostiole (Figs. 1, 2).

Perithecia of *M. zamiae* are unlike those of any of the other strains studied The walls are thinner and lighter in colour, and the neck or beak is much more pronounced and, in mature perithecia, is one to two times as long as the diameter of the perithecium (Fig. 1). The ostiole has a conspicuous fringe of pointed hairs or bristles, but the rest of the perithecium is glabrous

Shape and size of asci

The asci of the *Sordaria destruens* group are 8-spored, taper to a sterile base and dehisce by an apical pore. Exact measurements are difficult to obtain since in pressing open the perithecium the asci may be distorted. Asci of al



1. Longitudinal sections of perithecia. A, *Sordaria destruens* D (ii); B, *Melanospora zamiae*. × 250.

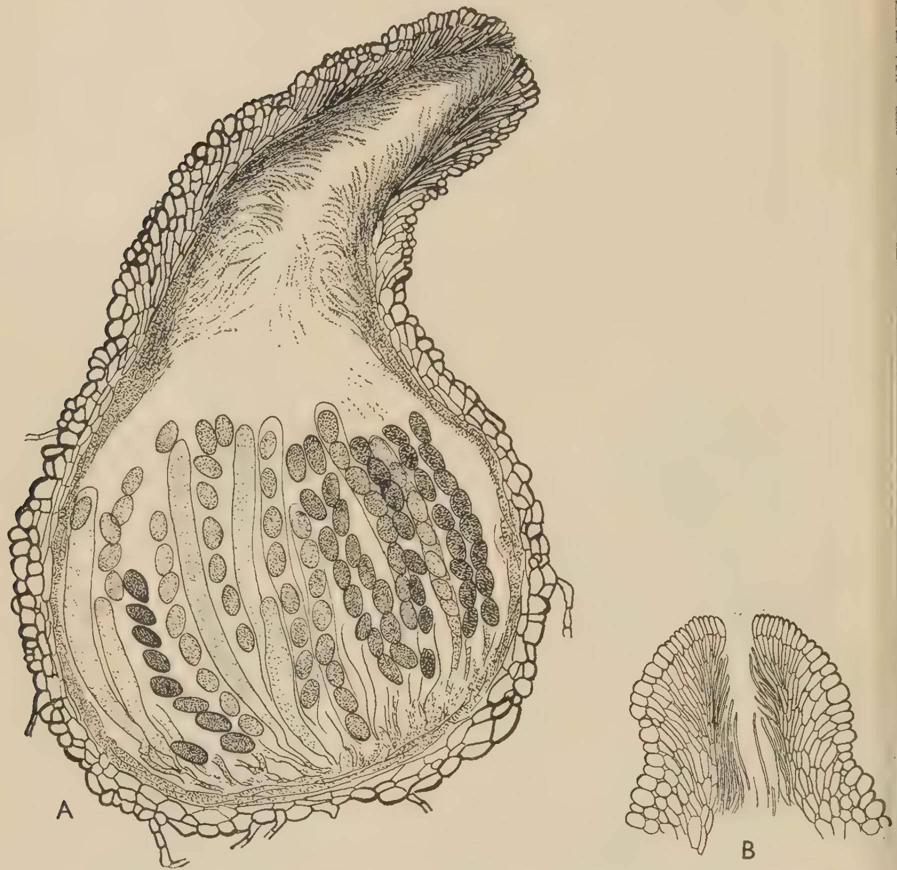


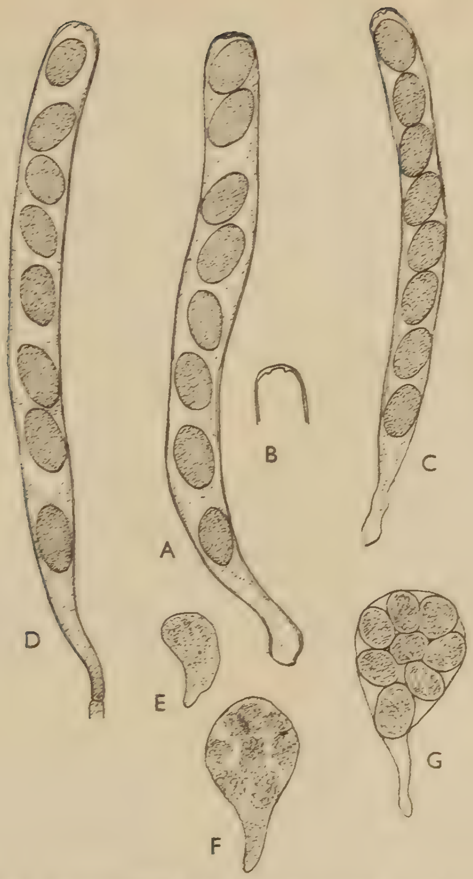
Fig. 2. Longitudinal section of perithecium of A, *Sordaria fimicola* F (iii); B, *S. fimicola* F (ii), L.S. ostiole and neck only. × 250.

three strains are apparently of similar size, viz. 164 × 12 μ approx. Those o the *S. fimicola* strains are closely similar to those of *S. destruens* but have a more rounded apex (Fig. 3, Table 1). No 4-spored or 5-spored forms such as those described by Page (1933) in a strain of *S. fimicola*, were observed

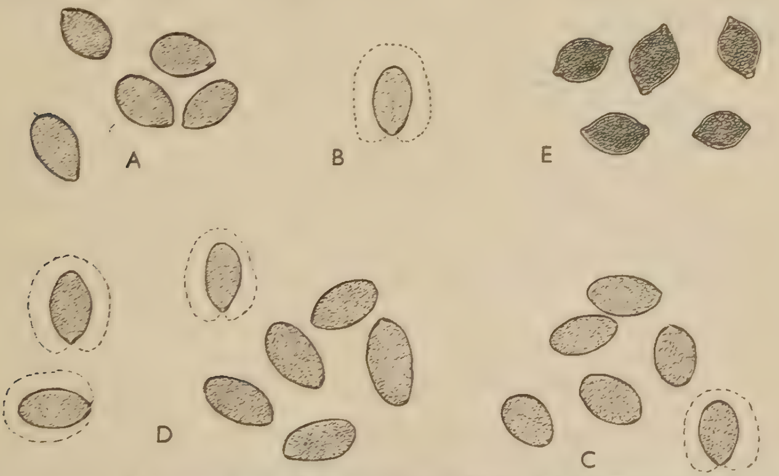
Asci of *Melanospora zamiae* are different from those of any of the other strains under examination. They are globose or ellipsoidal, 8-spored, with spores arranged in a group instead of in a single series, and the walls are evanescent (Fig. 3).

SHAPE AND SIZE OF ASCOSPORES

Ascospores of all strains are dark brown and appear black in the mass Those of *M. zamiae* are spindle-shaped with a germ-pore at each pole while mature spores of the other six strains are egg-shaped, tapering slightly towards base, with a single basal germ-pore. Young spores of these strains are more nearly spherical (Fig. 4), and all are of similar size (Table 1) No gelatinous or mucilaginous envelope can be demonstrated surrounding



ig. 3. Asci. A, B, *Sordaria destruens* D (ii), mature ascus showing apical pore and tip of immature one; C, D, nearly mature asci of *S. fimicola* (F (ii) and F (iii) respectively); E–G, stages in development of globose ascus of *Melanospora zamiae*. × 550.



ig. 4. Ascospores. A, mature spores of *Sordaria destruens* D (ii); B, immature spore of same strain showing gelatinous sheath; C, D, spores of *S. fimicola* (F (ii) and F (iii) respectively) some showing gelatinous sheath. E, *Melanospora zamiae*. × 550.

Table 1. *Dimensions of perithecia, asci and spores in microns*

Strain	Av. length of perithecium (including neck)	Av. width of perithecium	Av. length of neck of perithecium	Av. length and breadth of asci	Length and breadth of ascospores*
D (i)	470	369	90	165·1 × 12·4	23·1–(20·0)–15·0 × 13·8–(11·6)–10·2
D (ii)	468	358	90	162·5 × 12·0	25·5–(20·1)–14·5 × 13·6–(11·7)– 9·2
D (iii)	475	360	90	164·0 × 12·2	22·2–(20·0)–18·5 × 14·0–(12·0)–10·1
M.z.	495	115	240	70 × 35	19·0–(18·1)–16·2 × 12·1–(11·6)– 9·8
F (i)	492	400	100	—	24·0–(20·5)–17·3 × 13·0–(11·5)–10·0
F (ii)	509	410	90	170·0 × 12·5	23·8–(20·0)–16·3 × 13·4–(11·9)–10·2
F (iii)	566	420	105	213·3 × 15·0	24·5–(21·0)–18·0 × 14·0–(12·1)–10·5

* The bracketed figure in each case is the average.

mature spores of any strain. Young spores of the three strains of *Sordaria fimicola*, mounted in water, show a wide mucilaginous envelope (Fig. 4), but such an envelope is only present in a small proportion of the spores of the strains of *S. destruens*. Other young spores of the latter strains may show a narrower zone of mucilage or such a zone may be entirely absent. It is impossible to compare the incidence of this gelatinous envelope in the different strains since it depends upon the physiological age of the spores which is not readily estimated.

GERMINATION OF ASCOSPORES

Germination of ascospores of the D and F strains takes place after 4–5 hr. in 3 % malt extract. The first sign of germination is a swelling of the spore. A small bubble or papilla then protrudes through the single basal germ-pore and swells until it is about the size of the original spore (Fig. 5). The contents of the spore flow into the papilla as it develops and the spore wall becomes wrinkled and collapsed as a result of this loss of spore contents. One to three stout hyphae then grow out from the papilla which rapidly becomes vacuolate. Septa do not develop until the hyphae have grown to a considerable length (Fig. 5). Germination in these strains resembles that figured by Page (1933) for a strain of *S. fimicola* in the preliminary development of the papilla, but it differs in the development of more than one germ-tube from this swelling.

Ascospores of *Melanospora zamiae* germinate more slowly (taking about 12 hr. in weak malt extract). These spores first swell and then put out a slender germ-tube through each of the two polar germ-pores (Fig. 5). These germ-tubes have a slightly bulbous base and soon branch and become septate. The spore walls do not collapse as in the D and F strains but the empty spore is light in colour.

RATES OF GROWTH ON 3 % MALT AGAR AT VARIOUS TEMPERATURES

Plates of 3 % malt agar were inoculated with one or other of the seven strains and were incubated at a range of temperatures from 20 to 45° C. The results are given in Tables 2 and 3. The most striking features shown by the *Sordaria destruens* group (D (i), (ii) and (iii)) are the extremely rapid growth and the unusually high optimum and maximum temperatures (Table 3). Strains of *S. fimicola*, F (ii) and (iii), resemble them in these characters, but F (i) is slower growing although it also has a high optimum temperature. Strains D (i), D (iii), F (i) and F (ii) show slight growth even at a temperature as high as 40° C., but D (ii) and F (iii) fail to grow at 40° C. although they grow fairly well at 38° C. All are killed by 24 hr. exposure to a temperature of 45° C. All these strains grow relatively slowly at 20° C. No attempt was made to determine the lower limiting temperature.

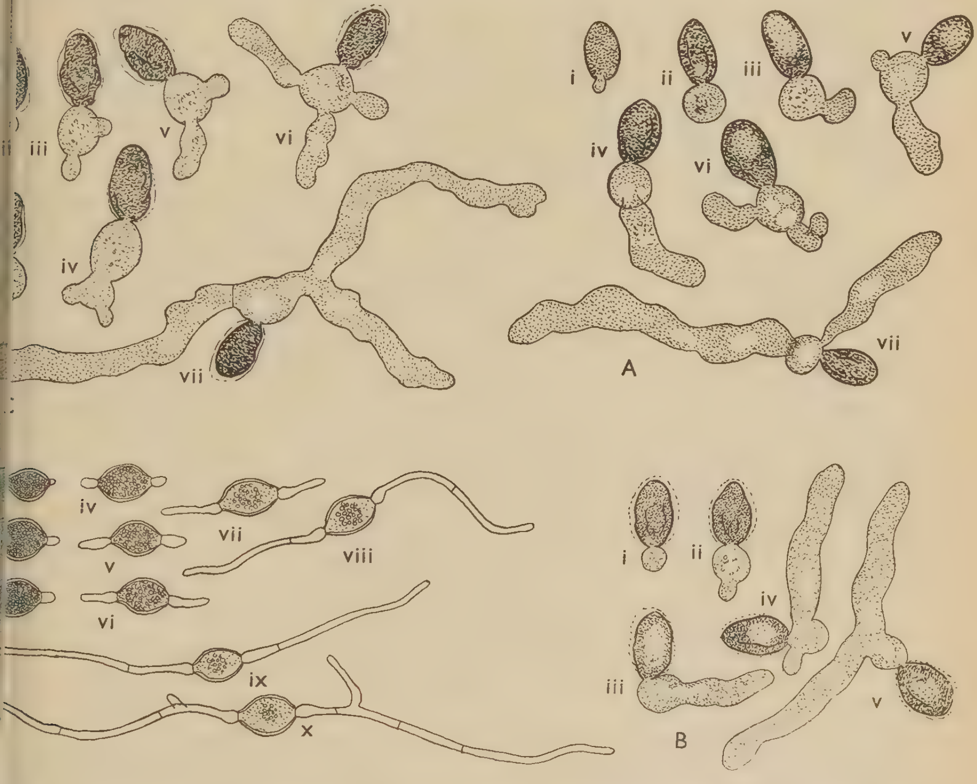


Fig. 5. Germination of ascospores in 3% malt extract. A, *Sordaria destruens* D (ii), i–vi after 5 hr. and vii after 8 hr. B, *S. fimicola* F (ii) i–iv after 5 hr., v after 8 hr.; C, *S. fimicola* F (iii), i–vi after 5 hr., vii after 8 hr.; D, *Melanospora zamiae*, i–vi after 12 hr., viii–x after 24 hr. × 550.

In contrast to the *S. destruens* and *S. fimicola* groups, *Melanospora zamiae* grows slowly and has the relatively low optimum temperature of 25° C. Growth is inhibited at 35° C. and the mycelium is killed by 24 hr. exposure to 38° C.

The results obtained for D (ii) do not agree, at first sight, with those of Asthana and Hawker (1936), who reported an optimum temperature of 25° C. when this strain was grown on a synthetic glucose-salts medium

Table 2. *Diameters of colonies in mm. at various temperatures and at various intervals after inoculation*

Strain	Temperature (° C.)	Hours after inoculation									
		10	24	30	41	48	54	63	73	90	114
D (i)	20	3·2	8·6	11·8	22·1	35·5	41·3	63·0	71·0	F.	—
	25	4·0	15·6	23·8	43·3	55·1	63·5	N.F.	F.	—	—
	30	6·0	20·5	33·6	54·0	69·0	F.	—	—	—	—
	35	8·0	26·1	39·4	65·0	F.	—	—	—	—	—
	38	5·1	13·2	16·0	21·0	22·1	23·2	24·0	24·7	25·5	—
D (ii)	20	2·0	7·1	10·3	19·8	28·6	35·8	51·0	58·5	F.	—
	25	3·2	11·3	17·5	29·0	39·5	47·5	65·2	73·1	F.	—
	30	4·8	14·0	21·8	36·6	48·4	59·5	69·3	F.	—	—
	35	5·0	14·4	26·4	44·1	73·1	F.	—	—	—	—
	38	5·5	9·8	11·6	22·8	30·5	34·1	38·0	41·7	41·8	—
D (iii)	20	2·2	7·0	14·3	31·8	47·0	58·3	F.	—	—	—
	25	6·0	19·7	26·1	46·3	61·7	71·0	F.	—	—	—
	30	10·1	28·8	46·5	N.F.	F.	—	—	—	—	—
	35	10·2	29·1	43·4	65·0	F.	—	—	—	—	—
	38	5·5	12·2	29·5	41·7	49·8	54·2	62·2	67·5	70·2	—
M.z.	20	None	1·0	2·0	3·1	5·9	8·0	12·9	15·1	23·3	31·2
	25	Neg.	1·8	3·0	9·1	12·3	18·0	26·5	33·0	41·2	53·1
	30	Neg.	1·2	2·5	7·3	11·0	13·5	18·2	22·5	27·1	33·3
F (i)	20	Neg.	1·0	1·6	10·3	13·5	18·0	20·5	23·8	28·6	34·1
	25	2·0	6·6	11·5	16·5	19·0	21·6	24·8	28·6	35·8	45·0
	30	3·2	10·0	15·8	23·0	31·5	40·0	45·5	52·7	64·5	N.F.
	35	2·2	5·0	8·0	13·5	16·1	19·0	28·0	36·1	43·5	52·0
	38	2·3	4·8	7·9	11·2	15·1	19·0	22·2	30·0	40·5	41·5
	40	2·0	4·6	6·8	8·2	11·6	12·0	—	—	—	12·2
F (ii)	25	Neg.	Neg.	5·0	12·5	24·1	30·6	46·5	56·1	F.	—
	30	3·6	10·0	23·8	50·8	66·1	71·5	F.	—	—	—
	35	5·5	17·8	46·2	74·5	F.	—	—	—	—	—
	38	5·0	20·6	32·8	46·8	56·0	60·0	67·9	73·6	F.	—
	40	Neg.	7·2	11·8	16·3	21·2	24·5	—	—	26·4	—
F (iii)	20	1·0	5·5	12·3	35·8	45·1	57·3	77·5	F.	—	—
	25	4·2	19·8	34·3	53·1	74·3	F.	—	—	—	—
	30	8·0	35·8	58·1	F.	—	—	—	—	—	—
	35	5·9	28·6	50·6	71·5	F.	—	—	—	—	—
	38	2·1	16·3	25·8	60·8	N.F.	F.	—	—	—	—

Neg. = negligible growth; N.F. = plate nearly full; F. = plate full.

Table 3. *Temperature optima and maxima for growth*

Strain	Optimum temperature (° C.)	Upper limit of temperature for growth (° C.)	Temperature lethal after 24 hr. exposure (° C.)
D (i)	35	40–45	45
D (ii)	35	38–40	45
D (iii)	30	40–45	45
M.z.	25	30–35	38
F (i)	30	40–45	45
F (ii)	35	40–45	45
F (iii)	30	38–40	45

* Growth occurred at the lower but not at the higher temperature.

(medium A). This strain no longer grows on medium A so that it is impossible to compare temperature relations on this medium with those on malt agar, but Hawker (1947*a*) has reported that the cardinal points for temperature for this strain vary according to the source of carbohydrate. On medium A with a supplementary dose of suitable growth substances, and with the amount of glucose increased from the standard concentration of 0·5–5·0 %, the optimal temperature was 30° C., but on a similar medium in which the glucose was replaced by sucrose it was only 25° C. It was suggested that this was due to the more rapid removal of this sugar by increased respiration so that sugar concentration became limiting at higher temperatures. Thus it is also probable that sugar concentration was limiting in Asthana and Hawker's experiment on medium A.

GROWTH SUBSTANCE REQUIREMENTS

Strains D (ii) and F (i) have been shown (Hawker, 1939*a*) to need biotin for mycelial growth while the addition of thiamin (aneurin, vitamin B_1) further increases mycelial growth and stimulates the formation of perithecia. Strain M.z. was unable to grow on an inositol-free fraction of lentil extract which was adequate as a source of growth substances for D (ii) and F (i) (Hawker, 1936).

Plates of medium A (glucose, 5 g.; KNO_3, 3·5 g.; KH_2PO_4, 1·75 g.; $MgSO_4$, 0·75 g.; agar, 15 g.; water, 1 l.) and of the same medium with the addition of biotin (4μg./100 c.c.), thiamin (4μg./100 c.c.) or *i*-inositol (20 mg./100 c.c.) separately or in various combinations were inoculated with one or other of the seven strains and incubated at 25° C. The results are shown in Table 4 in which the mycelial growth and perithecial production are represented by arbitrary signs. No strains produced perithecia in the absence of thiamin, and only F (iii) grew satisfactorily in the absence of biotin. Strain M.z. failed to grow satisfactorily in any of the media and obviously needed some further supplementary substances. It grew well on medium A plus a small quantity of a concentrated extract of lentils.

Table 4. *Effect of biotin, thiamin and inositol on growth and fruiting of the seven strains*

Strain	Medium A	A + biotin	A + thiamin	A + biotin + thiamin	A + biotin + thiamin + inositol
D (i)	o, o	*mm*, o	o, o	*mmm*, *ppp*	*mmm*, *ppp*
D (ii)	o, o	*mm*, o	o, o	*mmm*, *ppp*	*mmm*, *ppp*
D (iii)	o, o	*mm*, o	o, o	*mmm*, *ppp*	*mmm*, *ppp*
M.z.	o, o	*m*, o	*m*, o	*m*, *p*	*m*, *p*
F (i)	o, o	*m*, o	o, o	*mm*, *pp*	*mm*, *pp*
F (ii)	o, o	*m*, o	o, o	*mm*, *pp*	*mm*, *pp*
F (iii)	*m*, o	*m*, o	*mm*, *p*	*mmm*, *ppp*	*mmm*, *ppp*

m = very slight growth; *mm* = fair growth; *mmm* = good growth; *p* = few scattered perithecia; *pp* = fairly numerous perithecia; *ppp* = numerous perithecia. The first symbol in each column refers to mycelial growth, the second to perithecial production.

UTILIZATION OF VARIOUS CARBOHYDRATES

The effect of various carbohydrates on growth and fruiting of D (ii) has been fully investigated (Hawker, 1939*b*, 1947*b*), and Hawker and Chaudhuri (1946) have extended the investigation to include D (iii), F (i) and M.z. Mycelial growth of D (ii) increases with increased concentration of hexose sugar, but production of perithecia is inhibited by all but relatively low concentrations. In contrast, both growth and fruiting increase with increasing concentration of sucrose up to a relatively high level. Starch, maltose and lactose are intermediate in effect between glucose and sucrose. D (iii) and F (i) resemble D (ii) in their response to various carbohydrates but use sucrose less readily. M.z differs from D (ii), D (iii) and F (i) in several respects. Growth is less and perithecia are more numerous with fructose than with a corresponding amount of glucose. Growth is poor on starch, maltose, sucrose or lactose. The number of perithecia produced rises slightly with increase in concentration of maltose or lactose and falls off slowly with increase in that of starch or sucrose.

The seven strains under investigation were grown on medium A without agar, and with the standard amount of glucose replaced by 5·0% of glucose, fructose, sucrose, maltose, starch or lactose. Growth of M.z was poor in all the liquid media and was best on the maltose one and negligible with lactose or starch. Perithecia were formed with sucrose or maltose. The remaining strains grew well on all the media except the sucrose medium. Perithecia were produced on the sucrose, maltose and lactose media, but not on the glucose or fructose media.

LOSS OF FERTILITY BY *SORDARIA DESTRUENS* IN CULTURE

During experiments on the physiology of *S. destruens* (strain D (ii)) extending over a period of 14 years (Asthana & Hawker, 1936; Hawker, 1936, 1939*a*, *b*, 1942, 1944, 1947*a*, *b*, 1948) the strain gradually became less fertile. When first isolated it produced perithecia on a glucose-salts medium (medium A of Asthana and Hawker) in the absence of any external supply of growth substances. Later it ceased to fruit on this medium, but continued to grow fairly vigorously. Later still it produced a staled type of growth on medium A and at the present time growth is negligible on this medium. Growth and fruiting still occur, however, if the medium is supplemented with biotin and thiamin. On malt agar growth is still vigorous and of the non-staling type, but fruit-bodies are produced less freely than when the strain was first isolated. This loss of fertility is associated with loss of the ability to synthesize various growth substances.

The nature of the medium on which the stock cultures were maintained was varied and it was shown that growth-substance content (Tandon, 1939), nature of carbon compound supplied, concentration of medium, concentration of phosphate and nature and concentration of mineral salts had no influence on the general trend towards loss of fertility in culture. The length of the interval between two successive subculturings also had no significant effect on the rate of loss of fertility. Similar results were obtained with isolates of *S. fimicola* F (ii) from owl pellets.

Occasionally plate cultures of *Melanospora destruens* showed sectoring, and these sectors were usually less fertile than the parent culture. At relatively high temperatures (30° C. and over) the saltant sectors were occasionally more fertile than the parent. A number of these sterile and fertile saltants were picked up and hyphal tip cultures were made from them. The rate of growth of these strains at various temperatures was measured (Hawker, 1947*a*). At 20° C. the fertile strains showed a delay in growing out from the inoculum compared with the sterile strains and their growth rate was in general slower. At 30° C. the fertile strains began to develop at least as soon as the sterile ones and their growth rate was relatively higher. The average diameter of colonies of three fertile and three sterile strains, chosen at random, at 20 and 30° C. are shown in Table 5.

Table 5. *Average diameter of colonies of fertile and sterile strains of* Sordaria destruens *at* 20 *and* 30° *C.*

Strain	Temperature (° C.)	Hours after inoculation				
		22	30	46	58	75
Fertile	20	1·4	5·2	19·1	38·5	64·0
Sterile	20	5·5	11·1	21·3	40·3	78·0
Fertile	30	13·5	32·5	66·0	76·7	—
Sterile	30	11·6	28·1	53·8	78·5	—

From the data of Table 5, it is obvious that if progressive loss of fertility is due to the replacement of the parent strain by sterile saltants the latter will be favoured by incubation of subcultures at a temperature of 20° C. or lower. Conversely, one would expect incubation at a relatively high temperature to favour the more fertile strains. By the time this effect of temperature on the rate of growth of fertile and sterile strains was demonstrated the parent culture was already nearly sterile on ordinary media. The most fertile strain available was maintained in two lines, one of which was left at laboratory temperature after subculturing and the other was incubated for 3 days at 30° C. before being placed at laboratory temperature. Two years after the beginning of the experiment the first line had become nearly sterile while the second showed no significant further loss of fertility. A similar result was obtained with a strain of *Sordaria fimicola* similarly maintained for a shorter period. Incubation of new subcultures of strains of *Sordaria* for a few days at or above the temperature optimal for growth may thus prevent or delay loss of fertility in prolonged culture.

My sincere thanks are due to Mr E. W. Mason of the Commonwealth Mycological Institute, Kew, for drawing my attention to the anomalous position of *Melanospora destruens*, and to him and his colleague Dr S. J. Hughes for helpful discussion of the morphological data.

REFERENCES

Asthana, R. P. & Hawker, L. E. (1936). The influence of certain fungi on the sporulation of *Melanospora destruens* Shear and of some other Ascomycetes. *Ann. Bot., Lond.*, **50**, 325–343.

Brown, W. (1923). Experiments on the growth of fungi on culture media. *Ann. Bot., Lond.*, **37**, 105–129.

Corda, A. C. J. (1837). *Icones fungorum hucusque cognitorum.* 1. Prague.

Hawker, L. E. (1936). The effect of certain accessory growth substances on the sporulation of *Melanospora destruens* and of some other fungi. *Ann. Bot., Lond.*, **50**, 699–717.

Hawker, L. E. (1939*a*). The influence of various scources of carbon on the formation of perithecia by *Melanospora destruens* Shear in the presence of accessory growth factors. *Ann. Bot., Lond.*, N.S., **3**, 455–468.

HAWKER, L. E. (1939*b*). The nature of the accessory growth factors influencing growth and fruiting of *Melanospora destruens* Shear and of some other fungi. *Ann. Bot., Lond.*, N.S., **3**, 657–675.

HAWKER, L. E. (1942). The effect of vitamin B_1 on the concentration of glucose optimal for the fruiting of certain fungi. *Ann. Bot., Lond.*, N.S., **6**, 631–636.

HAWKER, L. E. (1944). The effect of vitamin B_1 on the utilisation of glucose by *Melanospora destruens* Shear. *Ann. Bot., Lond.*, N.S., **8**, 79–90.

HAWKER, L. E. (1947*a*). Effect of temperature of storage on the rate of loss of fertility of stock cultures of *Melanospora destruens*. *Nature, Lond.*, **159**, 136.

HAWKER, L. E. (1947*b*). Futher experiments on growth and fruiting of *Melanospora destruens* Shear in the presence of various carbohydrates, with special reference to the effects of glucose and sucrose. *Ann. Bot., Lond.*, N.S., **11**, 245–260.

HAWKER, L. E. (1948). Stimulation of the formation of perithecia of *Melanospora destruens* Shear by small quantities of certain phosphoric esters of glucose and fructose. *Ann. Bot., Lond.*, N.S., **12**, 77–79.

HAWKER, L. E. & CHAUDHURI, S. D. (1946). Growth and fruiting of certain Ascomycetous Fungi as influenced by the nature and concentration of carbohydrate in the medium. *Ann. Bot., Lond.*, N.S., **10**, 185–194.

PAGE, W. M. (1933). A contribution to the life history of *Sordaria fimicola* (four-spored form) with special reference to the abnormal spores. *Trans. Brit. mycol. Soc.* **17**, 296–301.

SHEAR, C. L. (1907). New species of fungi. *Bull. Torrey bot. Cl.*, **34**, 305–317.

SHEAR, C. L. & DODGE, B. O. (1927). Life histories and heterothallism of the red bread-mould fungi of the *Monilia sitophila* group. *J. agric. Res.* **34**, 1019–1042.

SHEAR, C. L., STEVENS, N. E. & BAIN, H. F. (1931). Fungous diseases of the cultivated cranberry. *Tech. Bull. U.S. Dep. Agric.* **258**, 1–56.

SMITH, G. (1946). *Industrial Mycology*, 3rd ed. London.

TANDON, R. N. (1939). Studies on the loss of fertility by certain fungi in culture. Thesis for the degree of Ph.D. in the University of London.

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THE OCCURRENCE OF *BOTRYTIS GLOBOSA* ON *ALLIUM URSINUM*

By J. WEBSTER and W. R. JARVIS
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(With Plate 6 and 1 Text-figure)

Although apparently common on *Allium ursinum*, *Botrytis globosa* Raabe has not previously been recorded in Britain. It is considered distinct from *B. sphaerosperma* (Gregory) Buchwald, and *B. squamosa* Walker.

Plants of *Allium ursinum* with leaves showing dark green, collapsed, water-soaked areas, which sometimes extended over the whole leaf, were collected at Wauldby, near Hull, on 5 June 1948. On the lower surface the lesions were covered by a grey felt of conidiophores. Examination of the fungus showed that it agreed very closely with *Botrytis globosa* described by Raabe on *Allium ursinum* from Tübingen, and various other localities in Germany (Raabe, 1938). The specimen is deposited in the Herbarium of the University College of Hull, No. 642. Further collections of the fungus have since been made and are deposited in the Mycological Herbarium of the University of Sheffield:

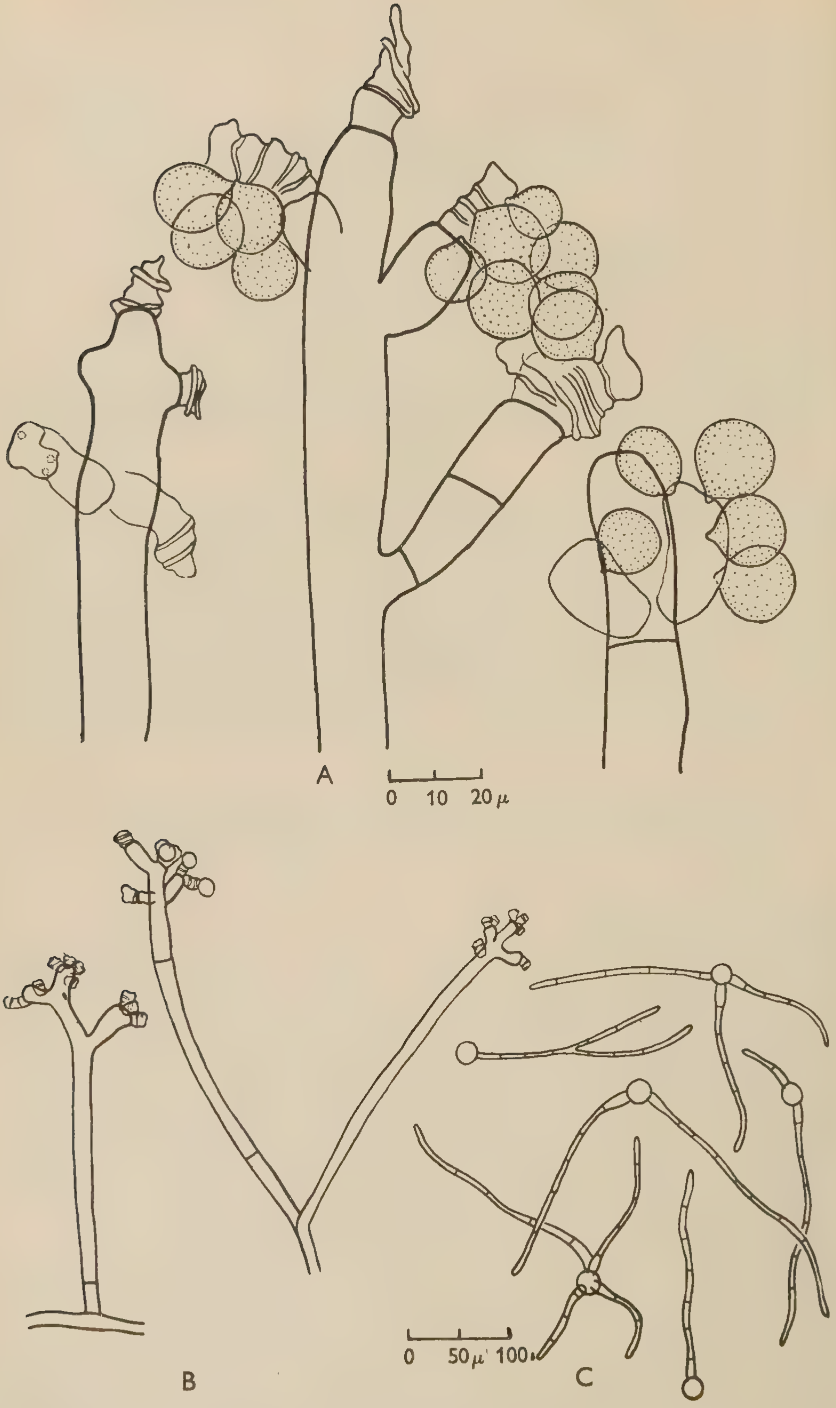
Anston Stones Wood, South Anston, Yorks. 20 May 1950.
Birkhill Wood, near Beverley, Yorks. 4 June 1950.
Totley Wood, near Sheffield, Yorks. 15 June 1950.

Although the fungus is common, it has apparently not been previously recorded in this country.

The conidiophores arise on the lower surface of the leaf; they are dark in colour, branched and septate (see Text-fig. 1 B), are 300–900 μ long and 10–20 μ wide, more narrow at the base and widening at the apex beneath the spore-bearing branches. The conidia are produced on short, cylindrical, thin-walled lateral branches. After the spores have been shed or on drying, the spore-bearing branches collapse in a peculiar 'concertina-like' manner, presumably due to the presence of rims of thicker material in the wall (see Text-fig. 1 A and Pl. 6, fig. 3). The conidia are globose or somewhat pear-shaped, with a distinct papilla of attachment (see Text-fig. 1 A), and measure 10–18 μ, usually 13–15 μ in diameter (forty measured in water). They germinate rapidly, producing 1–4 germ tubes (see Text-fig. 1 C).

Black, shining, linear sclerotia, 3–15 mm. in length and 1–2 mm. wide are formed along the midrib of the leaf during late June and July (see Pl. 6, fig. 2). The behaviour of these sclerotia has not been observed.

Buchwald (1949) places *Botrytis globosa* in his subgenus *Sphaerobotrytis* including 'only four species at present, differing from the typical *Botrytis* species primarily by having globose, often large conidia with a diameter of about 20–50 (–90!) μ.' He further points out that apothecial states are



Text-fig. 1. A, conidiophore apices of *Botrytis globosa*; B, branched conidiophores; C, germinating conidia after 24 hr.

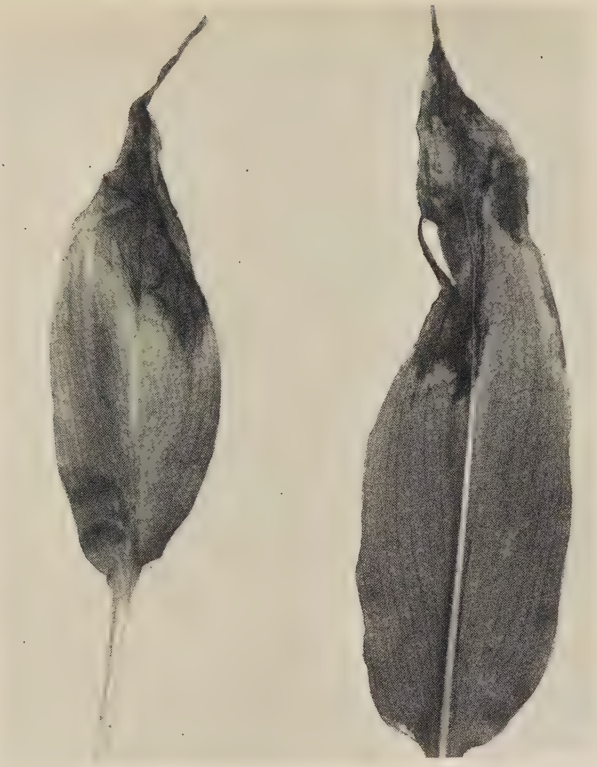


Fig. 1.

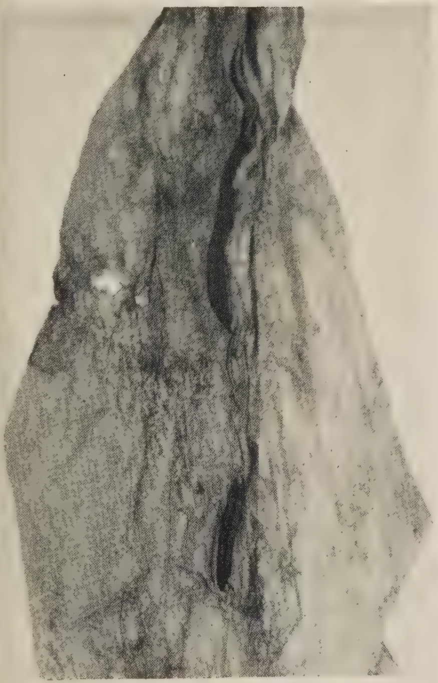


Fig. 2.

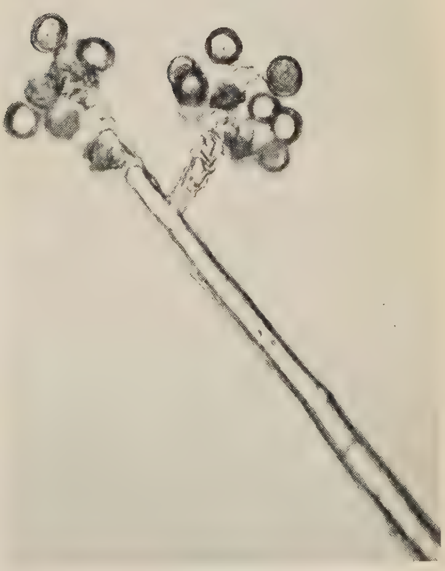


Fig. 3.

nown in all species of this subgenus with the exception of *B. globosa*. The oup also includes the conidial stage of *Sclerotinia sphaerosperma* (named *otrytis sphaerosperma* by Buchwald) described by Gregory (1941) from *llium triquetrum*. Gregory notes that this is very similar to *Botrytis globosa*, ut differs from it in having larger spores (about 23 μ).

Various other species of *Botrytis* are known to occur on species of *Allium*. n particular, *Botrytis squamosa* Walker, has been shown to be the cause of neck rot disease of onion bulbs in America (Walker, 1925, 1926), and as been associated with a dieback disease of onion foliage in Britain Hickman & Ashworth, 1943). This species also shows the characteristic ethod of collapse of the conidiophores referred to above, and described y Walker as forming 'accordion-like folds'.

Although we have not studied material of *B. squamosa*, the published escriptions and figures show that the fungus is distinguishable from *B. lobosa* by the shape and size of the conidia, which in *B. squamosa* are lliptical, and measure 13–24 × 9–18 μ (usually 15–22 × 11–15 μ), usually erminating by a single germ tube only. Buchwald places this species in is subgenus *Eubotrytis*.

Our thanks are due to Mr E. Barron for his assistance with the photoraphy.

REFERENCES

BUCHWALD, N. F. (1949). Studies in the *Sclerotiniaceae*. I. Taxonomy of the *Sclerotiniaceae*. *K. VetHøjsk. Aarsskr.* pp. 75–191.

GREGORY, P. H. (1941). Studies on *Sclerotinia* and *Botrytis*. I. *Trans. Brit. mycol. Soc.* **25**, 26–40.

HICKMAN, C. J. & ASHWORTH, D. (1943). The occurrence of *Botrytis* spp. on onion leaves with special reference to *B. squamosa*. *Trans. Brit. mycol. Soc.* **26**, 153–157.

RAABE, A. (1938). Parasitische Pilze der Umgebung von Tübingen. *Hedwigia*, **78**, 71.

WALKER, J. C. (1925). Two undescribed species of *Botrytis* associated with the neck rot diseases of onion bulbs. *Phytopathology*, **15**, 708–713.

WALKER, J. C. (1926). *Botrytis* neck rots of onions. *J. agric. Res.* **33**, 893–928.

EXPLANATION OF PLATE 6

Fig. 1. Leaves of *Allium ursinum* showing lesions caused by *Botrytis globosa* (× 0·6).
Fig. 2. Sclerotia of *Botrytis globosa* formed along the midrib of the leaves of *Allium ursinum* (× 2).
Fig. 3. Conidiophore of *Botrytis globosa* (× 373).

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SOME NEW DISCOMYCETE RECORDS

By W. D. GRADDON, *Congleton, Cheshire*

(With 4 Text-figures)

Hyalopeziza ciliata, *Karschia cratincola*, *Ploettnera exigua*, *Mollisia phalaridis* and *Pyrenopeziza fuckelii* are recorded for the first time in England, and are described and illustrated from living material.

The purpose of this paper is to describe five species of inoperculate discomycetes apparently not hitherto recorded for Britain. These have come to notice in the course of continual searching of the Cheshire-Staffordshire border country near Congleton. Some 200 species have been found of which the more interesting have been noted from time to time in the *Transactions of the North Staffordshire Field Club* from 1942 onwards. The stretch of country has no extensive woodlands and is mainly under agriculture; it is hilly, and the hillsides are frequently deeply scored by small tributaries of the River Dane; the resulting narrow, well-wooded and sheltered 'cloughs' have provided the majority of the species. The following descriptions are drawn from fresh material and spore measurements are taken from spores freely thrown by living specimens and collected on cover-glasses.

Hyalopeziza ciliata Fuckel *Symb. mycol.* p. 298 (1869)

Lachnum ciliatum Rehm, *Rabenh. Kr. Fl.* **3**, 878 (1893)

Minute, about 0·25 mm. across excluding the hairs. Superficial, sessile, thin, narrowed below to a small central umbo of attachment. Wholly white. Rather scantily clothed with long, rigid, pointed, hyaline, spreading hairs, to 160 μ long and 6–7 μ thick just above the base; hairs thick-walled and 3- to 6-septate with very delicate septa, minutely rough and often bearing along their length rough agglomerates of crystals. The hairs do not form a marginal fringe but grow at random from all parts of the excipulum; an apothecium carries about fifty hairs. Asci 28–45 × 5 μ, very numerous, 8-spored, cylindric-clavate, almost sessile, apex rounded, pore blued by iodine. Spores 5–6·5 × 2·5–3 μ, ovate, hyaline, continuous. Paraphyses, none found (Fig. 3).

Several small colonies on 1-year-old fallen leaves of sycamore, Moreton near Congleton, October 1944.

A species very difficult to find and remarkable in the length of the hairs which approaches or even exceeds the diameter of the body; this feature shows well in a photograph by Nannfeldt (1932, p. 272, plate XII, fig. 1).

Karschia cratincola Rehm, *Rabenh. Kr. Fl.* **3**, 348 (1890)

Minute, about 0·2 mm. across and 0·12 mm. high. Superficial, subglobose, broadly sessile. Wholly black. Margin rounded and somewhat

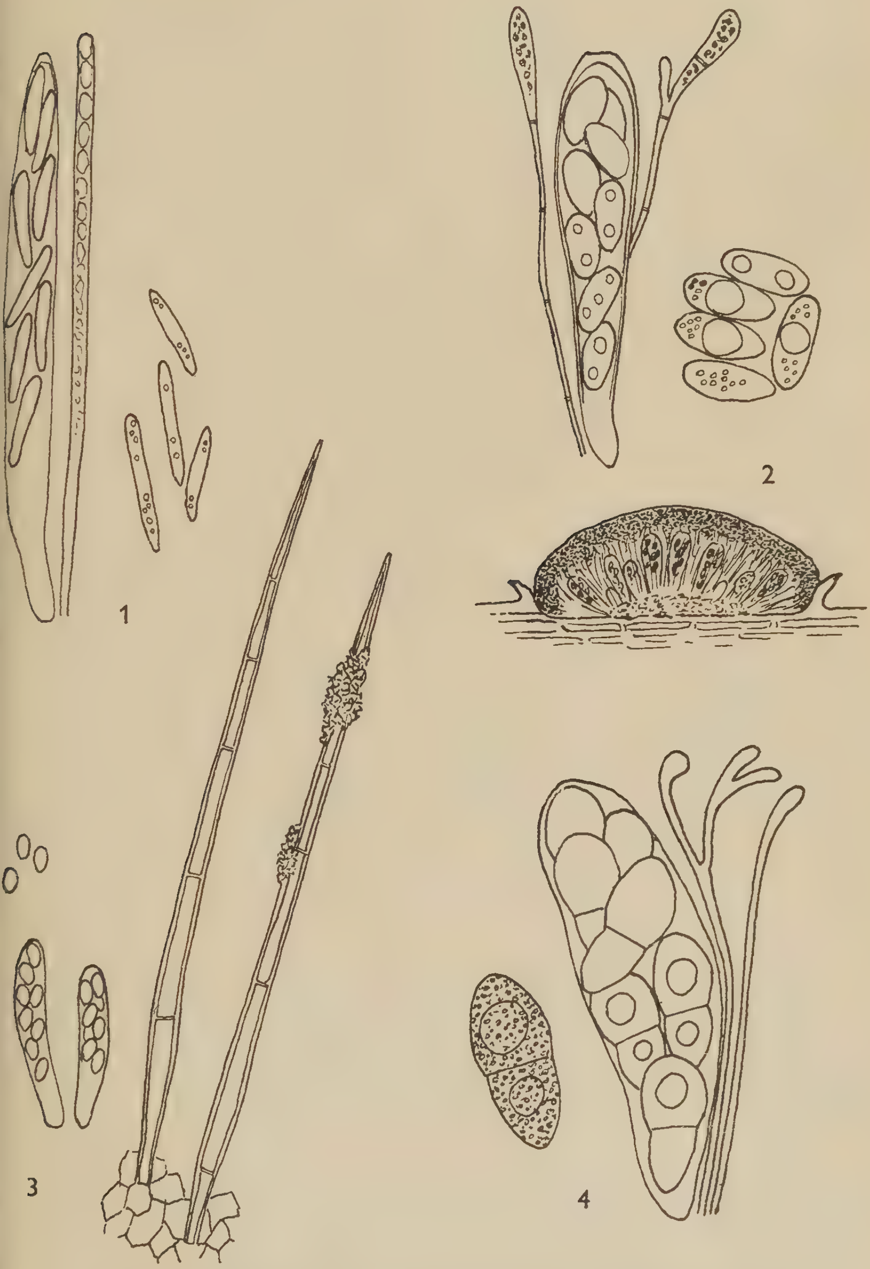

Fig. 1. *Mollisia phalaridis* Rehm; ascus, paraphysis and spores, × 630.
Fig. 2. *Ploettnera exigua* (Niessl) v. Höhnel; ascus and paraphyses, × 630; and median section of apothecium, × 125.
Fig. 3. *Hyalopeziza ciliata* Fuckel; hairs, asci and spores, × 630.
Fig. 4. *Karschia cratincola* Rehm; ascus, paraphyses and spores, × 630.

undulate; disk slightly concave. Externally glabrous but minutely roug with cell projections. Asci 90 × 30 μ when containing coloured spores shorter and broader while the spores are yet hyaline, broadly clavate almost sessile; apex narrowed and rounded, the pore not blued by iodine Some asci appear to develop less than eight spores and many spores seem to remain hyaline and immature. Spores 34–39 × 15–17 μ, broadly ovat with bluntly pointed ends, yellowish brown; divided by a slender septum into two unequal cells each containing one large guttula; the cell conten is granular and the wall constricted at the septum. Paraphyses slightl exceeding the asci above which their apices form a brown epithecium filament slender, about 1·5 μ; several times branched towards the apex Hypothecium narrow, pale brownish. Excipulum of brown angular cell about 10 μ across (Fig. 4).

Plentiful on a waterlogged, decorticated branch at Congleton, November 1943.

Ploettnera exigua (Niessl) v. Höhnel, *S.B. Akad. Wiss. Wien*, Abt. I. **127**, 556 (1918).

Pseudopeziza exigua Niessl, *Hedwigia*, **15**, 107 (1876).

Erumpent from just within the epidermis of the host which splits int two or three lobes and embraces the apothecium; exposed disk black convex, circular or slightly elongate, about 0·5 mm. across. Asci 90 × 18 μ 8-spored, broadly clavate on a short pedicel, apex rounded, the rather large pore coloured pale purple by iodine. Spores 16–19 × 6·5–8 μ, oblong-elliptic, hyaline, continuous, containing one large central guttula or tw rather smaller ones, also many minute ones. Paraphyses slightly exceeding the asci above which their apices form a clear blue-green epithecium filament slender, about 1·5 μ, septate, enlarged above to a globose or clavate head 8 μ across, which is filled with green granules; mostly simple but some with poorly developed branching just below the head. Hypothecium scanty, hyaline. Excipulum none (Fig. 2).

In considerable colonies on dead stems of *Rubus fruticosus* agg., at Astbur near Congleton, January 1945.

The spores in some asci become stained blue-green like the epithecium such spores seem not to be ejected as they were absent from all spore-throws taken. Sometimes the surface of the host is stained blue-gree around the apothecia. Von Höhnel (1918*a*, *b*) has cleared up certain confusions in the synonymy and descriptions of this species and the Congleto material is in excellent agreement with the species as he understood it.

Mollisia phalaridis (Lib.) Rehm, *Rabenh. Kr. Fl.* **3**, 548 (1891).

Superficial, sessile on a broad base, about 1·5 mm. across. Disk flat, pal yellowish grey to clear ivory; externally smooth, slightly brownish; margi concolorous and scarcely distinguishable. Asci 80–90 × 8 μ, 8-spored cylindric-clavate, on a short slender pedicel; apex conspicuously narrow-elongate, pore not blued by iodine. Spores 20–30 × 2·5 μ, cylindrical wit tapered ends, hyaline, continuous, containing several minute guttula usually collected in a cluster towards each pole. Paraphyses same length as asci, very slightly enlarging upwards to about 3 μ across, hyaline, aseptate and filled with globules. Hypothecium well-developed, hyaline. Excipulum of pale-straw, rounded cells about 13 μ across, becoming smaller and elongate towards the margin (Fig. 1).

In plenty on dead stems of *Phalaris arundinacea* at Rudyard Lake, Staffs., May–July 1942 and subsequent years.

Distinct from all our other Mollisias in its much larger, aseptate spores.

Pyrenopeziza fuckelii Nannf., *Svensk bot. Tidskr.* **25**, 1–31 (1931)

Developing initially within the tissue of the host but becoming apparently superficial at a very early stage. At maturity about 0·4 mm. across. Disk pale- to dark-grey surrounded by a spreading whitish, rather ragged margin; in some specimens the disk finally became the brown colour of a sere leaf, the whitish irregular margin still conspicuous. Asci 37–40 × 7 μ, 8-spored, clavate, almost sessile, apex rather pointed, pore blued by iodine. Spores 8–10 × 1·5–2 μ, elongate spindle-shaped, continuous, hyaline, usually containing four small guttulae. Paraphyses rather scanty, forked near the base, each limb enlarging to a clavate apex about 3 μ across. Basal cortex cells rounded-polygonal, yellowish brown, about 8 μ across; marginal cells 18–25 × 5–6 μ, hyaline, aseptate, agglomerating into bundles to form the irregular margin.

In plenty on the underside of dead leaves of *Salix caprea* at Rushton, Staffs., May 1943 and subsequent years.

A species which at maturity shows little or no sign of its erumpent origin. Extensive sectioning of leaf tissue adjacent to colonies of apothecia provided several examples of minute unopened fruit bodies still completely within the unbroken epidermis of the host. Nannfeldt (1931) should be consulted for a thorough review of this and other species which occur on *Salix* leaves.

My grateful thanks are due to Miss E. M. Wakefield for continual help and encouragement in this work.

REFERENCES

Höhnel, F. von (1918*a*). Über *Phacidium pusillum* Libert. Fragmente zur Mycologie No. 1094. *S.B. Akad. Wiss. Wien*, Abt. 1, **127**, 552.

Höhnel, F. von (1918*b*). Über *Ploettnera coeruleo-viridis*. Fragmente zur Mycologie No. 1097. *S.B. Akad. Wiss. Wien*, Abt. 1, **127**, 555.

Nannfeldt, J. A. (1931). Contributions to the mycoflora of Sweden. 2. *Excipula sphaeroides* Fr., some other discomycetes on *Salix* leaves and their conidial stages. *Svensk bot. Tidskr.* **25**, 1–31.

Nannfeldt, J. A. (1932). Studien über die Morphologie und Systematik der nichtlichenisierten, inoperculaten Discomyceten. *Nova Acta Soc. Sci. upsal.* (ser. 4), **8**, no. 2, 1–368.

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FURTHER RECORDS OF BRITISH PREDACIOUS FUNGI. II

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(With 8 Text-figures)

Predacious hyphomycetes new to Britain are *Dactylaria gracilis* n.sp., preying on nematodes on mosses; also *Arthrobotrys conoides*, *Dactylaria psychrophila*, *Dactylella asthenopaga*, *D. heterospora*, *Acrostalagmus obovatus*, *Cephalosporium balanoides*, *Harposporium oxycoracum*, *Nematoctonus tylosporus* and *Spicaria coccospora*. Zoopagaceae not previously recorded from this country include *Acaulopage baculispora*, *A. ischnospora*, *Stylopage rhicnacra* and *Zoopage thamnospira*.

A. Predacious hyphomycetes

Dactylaria gracilis sp.nov.

Mycelium hyphis rectis, septatis, parce ramosis, 2–4 μ crassis, laqueos circulares plerumque 24–33 μ latos in 3 cellulis consistentes ex ramulo biloculari 12–20 μ longo, 3–4 μ crass proferentibus; his laqueis vermiculos nematodeos per constrictionem capientibus deind hyphas edentes intra vermiculum quae carnem exhaurient evolentibus. Conidia hyalina fusiformia, leniter curvata, 46–66 μ longa, 7–11 μ crassa, plerumque in 4–5 cellula ultima bis longa quam paenultima cellula, divisa, ad apices hypharum fertilium erectorum 150–300 μ altos aggregata.

Vermiculos nematodeos capiens consumensque apud bryophyta diversa prope Marlborough, South Devon, September 1948.

A hyphomycete which captured nematodes by means of constricting rings was isolated from a collection of bryophytes found growing on a ban at the side of a field near Marlborough, Devon. Small portions of th bryophyte material, with soil adhering to the rhizoids, were placed on plates of sterile maize-meal agar. After incubation at room temperature for 6 weeks, erect conidiophores were observed bearing loose apical whorl of elongated, multiseptate conidia, clearly belonging to a species of *Dactylaria*. These conidiophores arose from the inoculum itself, or from the surface of the agar close to it.

A few days later, it was observed that nematode worms were being captured by a fungus whose hyphae bore constricting rings of the kind described by Drechsler (1937) for *Dactylella bembicoides*, and the connexion between these ring-bearing hyphae and the *Dactylaria* was established. It seemed at first that the fungus was identical with *D. brochopaga* Drechsler (1937), but further observation showed that it was a different species.

The mycelium was scanty, consisting of straight, septate hyphae sparingly branched, the branches usually diverging rather widely from one another. The hyphae were 2–4 μ wide. At intervals the mycelium bore nearly circular, stalked rings, each of which was made up of three cells Each cell was bent in the form of an arc of a circle, and was wider in the centre than at the ends (Fig. 1*a*); the cytoplasm contained one large vacuole or a number of smaller ones. Each ring was 25–33 μ in outside diameter, and was carried on a two-celled stalk, usually 12–20 μ long and 3–4 μ wide. Most of the rings were placed just below, and perpendicular to, the surface of the agar.

Nematode worms were captured in the rings by constriction. When a nematode moving on or near the surface of the agar pushed its head through one of the loops, the three cells underwent rapid swelling, so that the opening was almost obliterated. This seemed to be brought about by sudden enlargement of the vacuoles. As a result, the eelworm was deeply constricted at the point where the ring closed on it, and held like a rabbit in a snare in spite of frantic struggles to get away. Death of the nematode followed shortly after capture.

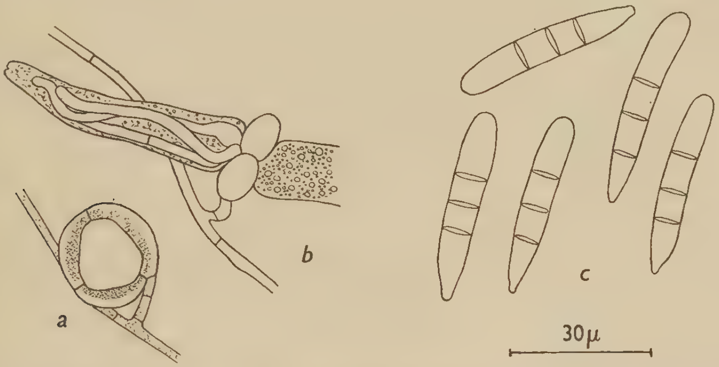

Fig. 1. *Dactylaria gracilis* n.sp., drawn from preparations stained in chlorazol black E and mounted in 'Euparal'. *a*, part of mycelium, bearing a ring; *b*, anterior end of a captured nematode, showing development of trophic hyphae; *c*, conidia.

When the prey had become moribund, invasion of its body by trophic hyphae began. These were mostly about 3 μ in diameter, and they grew out from the cells of the ring, penetrating the integument of the worm and spreading throughout its body, absorbing the tissues completely (Fig. 1*b*).

The fungus formed spores rather sparingly, the conidiophores arising at first from the inoculum itself and later from hyphae which had grown out into the agar medium. The conidiophores were erect, rising to a height of 150–350 μ above the substratum. At the apex of the conidiophore, which was usually unbranched, about six conidia were carried in a rather loose head. The conidia were fusiform, somewhat curved, bluntly rounded at the distal end and rather more pointed at the proximal end (Fig. 1*c*). They were 46–66 μ long and 8–11 μ wide, and each conidium was usually divided by transverse septa into four or five cells, of which the terminal cell was regularly about twice as long as the cell adjacent to it; the proximal cell also was usually, though not always, similarly elongated. A small number of conidia was observed in which, apparently through imperfect development, the proximal and terminal cells were not elongated; these conidia often had fewer cells and were smaller, being mostly 22–31 × 5–9 μ.

Permanent preparations were obtained by the method described by

Armitage (1945). Thin slices of agar bearing the fungus were stained with chlorazol black E after fixing in 70% alcohol, and mounted in 'Euparal'.

The fungus was isolated into pure culture by picking off conidia on an agar block at the point of a sterile needle. Growth in pure culture was slow, and on maize-meal agar the mycelium was flat and glistening white. It sporulated more freely in pure culture, though never really abundantly, and the conidia were smaller, measuring 36–53 × 6–11 μ, with a larger proportion imperfectly formed. Ring traps were not formed in pure culture.

Morphologically, this fungus closely resembles *D. brochopaga* Drechsler, but it differs significantly in the greater length of its conidia, and in the regularity with which the distal cell of the conidium is about twice the length of the penultimate cell. It seems necessary, therefore, to accommodate it in a separate species, and the binomial *D. gracilis* is proposed, the epithet being chosen on account of the long, slender conidia.

In addition to the type collection from Marlborough, this fungus has been obtained from a collection of moss, *Hypnum cupressiforme* L., from Epping Forest, November 1949.

Type material has been deposited in the Herbarium of the Commonwealth Mycological Institute, Kew, and in the Herbarium of the Royal Botanic Gardens, Kew.

Arthrobotrys conoides Drechsler in *Mycologia*, **29**, 476 (1937).

This fungus was obtained in November 1949 from a collection of horse dung of unknown origin, delivered for use as garden manure near Kingston-on-Thames, Surrey.

A. conoides captured nematode worms by means of adhesive networks, similar to those used by *A. oligospora* Fres. The mycelium developed quickly and in quantity when sterile plates of maize-meal agar were inoculated by placing a small piece of the dung in the centre of each plate. The hyphae were septate, 3–5 μ wide, and three dimensional networks were formed by anastomosing lateral branches which curled round and linked up with the main hypha and with one another (Fig. 2*a*). The individual loops were 38–60 μ in outside diameter and 27–48 μ in inside diameter. Vegetative growth was strong; in cultures containing nematodes, the fungus soon covered the surface of the agar, extending from the inoculum radially to all parts of the plate. Nematodes were captured in large numbers by adhesion to the networks, and in material mounted in water it was possible to see under the microscope the colourless viscous fluid by means of which they were held.

Nematodes did not live long after they were captured. After a period of intense struggling they became still and apparently moribund. The integument of the nematode was then penetrated by an outgrowth from the fungus, and this outgrowth formed a subspherical infection bulb within the body of the eelworm, the diameter of the bulb when fully grown being usually somewhat less than that of the nematode. From the infection bulb, trophic hyphae grew out and spread throughout the carcass of the animal, absorbing its contents (Fig. 2*b*). The trophic hyphae were at first non-septate, but septa were soon developed, and as the absorption of the internal organs of the nematode neared completion, the trophic hyphae began to lose their cytoplasm, the evacuation taking place progressively from the distal end. The sequence of events differed in no important respect from the same process in *A. oligospora* (Zopf, 1888; Drechsler, 1937).

Sporulation in nematode-containing cultures was very abundant, both on the inoculum itself and on the surrounding medium, and was unusual in that capture of nematodes by hyphae which had grown out from the inoculum on to the surface of the agar did not occur until after the initial burst of sporulation was over. It is possible that this phenomenon was connected with the nutritive richness of horse dung.

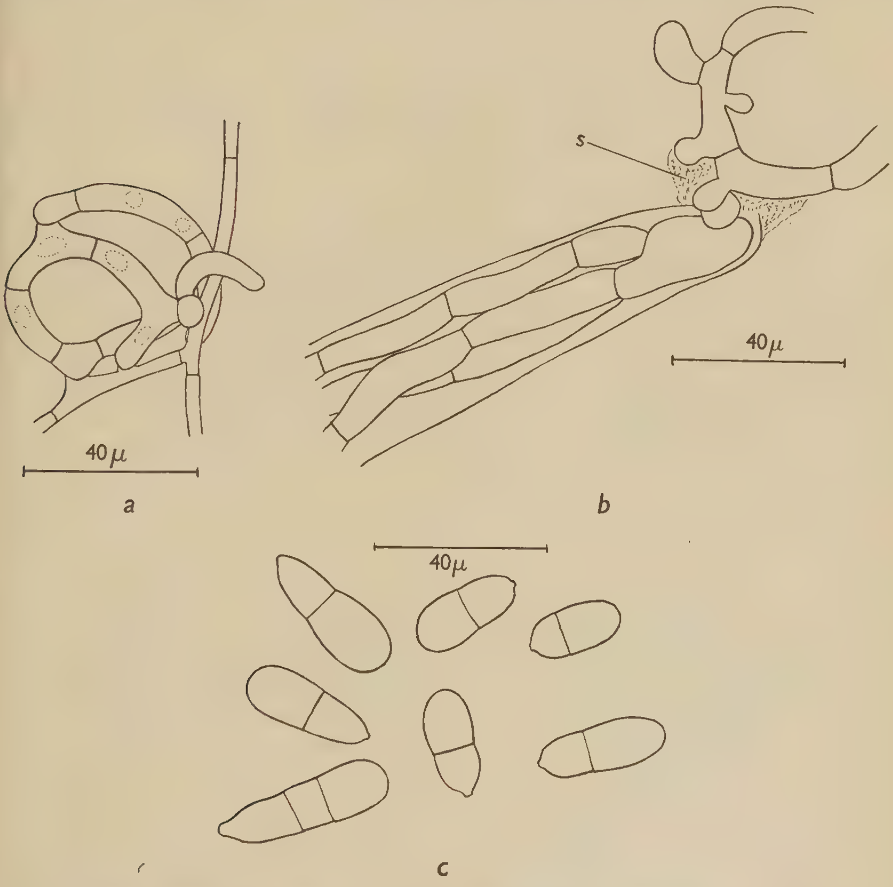

Fig. 2. *Arthrobotrys conoides* Drechsler. *a*, part of mycelium, with developing networks; *b*, anterior end of a nematode captured by a loop of the networks (at *s* the adhesive fluid holding the prey can be seen); *c*, conidia.

The fertile hyphae rose erect to a height of 130–300 μ above the substratum. They were usually unbranched. Each bore at its apex about a score of conidia, arranged in a tightly packed, globular head. The conidia were rectangular-pyriform, each one divided by a single transverse septum into two cells of approximately equal length. The conidia measured 21–36 × 9–13 μ. Occasionally somewhat larger conidia were observed which were divided by two transverse septa (Fig. 2*c*).

The fungus was easily isolated into pure culture by picking off conidia. It grew well on maize-meal agar and on potato-carrot agar. Sporulation in pure culture was very profuse, the conidia, which were somewhat smaller than those formed in cultures containing nematodes, being formed in a number of whorls along the distal half of the conidiophore. The conidia germinated readily, germ tubes arising from one or both of the cells.

Dactylaria psychrophila Drechsler in *Mycologia*, **36**, 141 (1944).

D. psychrophila was found capturing nematodes in a collection of the moss *Bryum argenteum* L. from between paving stones in a street near Kingston-on-Thames, Surrey, in January 1949.

In its general characters, this fungus showed no important differences from other reticulate hyphomycetes. The mycelium consisted of septate hyphae, 3–6 μ in diameter. Nematodes were captured by means of adhesive networks, formed in the usual manner by anastomosing hyphal branches; these networks were three-dimensional and somewhat complex, but the individual loops were of rather smaller diameter than is usual, measuring 24–40 μ in external diameter and 12–28 μ in internal diameter (Fig. 3*a*). Nematodes were captured and held apparently by adhesion to the networks, although no adhesive substance was visible under the microscope.

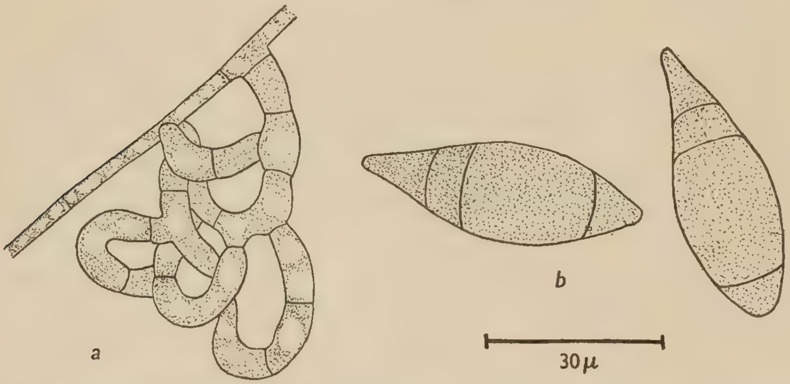

Fig. 3. *Dactylaria psychrophila* Drechsler, drawn from preparations stained with chlorazol black E and mounted in 'Euparal'. *a*, networks; *b*, conidia.

When a captured nematode had become moribund, its integument was pierced by an outgrowth from the fungus, which formed an infection bulb within the animal. From this infection bulb, trophic hyphae grew out and ramified throughout the interior of the eelworm, absorbing its contents. The trophic hyphae were septate, at least in the later stages of their development, and were mostly 3–5 μ in diameter.

Sporulation occurred somewhat sparingly, after the fungus had fed for some days on nematodes. The conidia were at first formed singly at the apices of erect conidiophores which rose 200–400 μ above the surface of the agar; later additional conidia were produced, forming a loose panicle at the apex of the conidiophore. The conidia were ovate-pyriform, and measured 42–52 × 19–24 μ; they were divided by two or three transverse septa into three or four cells, of which one of the inner ones was much the largest (Fig. 3*b*).

The fungus was isolated into pure culture, and grew well on maize-meal agar and on potato-carrot agar. Sporulation was profuse in pure culture, but no traps were formed, and the conidia were somewhat smaller, measuring 39–52 × 15–21 μ, and were nearly always three-septate. There was a strong tendency to form conidia singly instead of in panicles.

A notable character of this species is the way in which the formation of the typical panicles of conidia is postponed until the culture is old. A young culture of *Dactylaria psychrophila* could easily be mistaken for a *Dactylella*.

Dactylella asthenopaga Drechsler in *Mycologia*, **29**, 499 (1937).

I have found this fungus at three stations in this country: (1) in decaying wood, near High Beech, Epping Forest, October 1948; (2) in rotting wood and other debris from a hole at the base of the trunk of an oak (*Quercus petraea* (Matt.) Liebl.), Wimbledon Common, October 1948; and (3) in leaf-mould, near a rotting beech stump, Epping Forest, November 1949.

The mycelium consisted of straight, sparingly branched, septate hyphae, 2–4 μ wide. The hyphae bore at intervals short, mostly unicellular lateral processes, 3–10 μ long and 2–3 μ wide, standing out at right angles to the hyphae that bore them and usually perpendicular to the surface of the agar. Each process ended in a subspherical knob, 6–8 μ long and 5–7 μ wide, composed of a single cell.

An eelworm coming into contact with one of the knobs was held fast, presumably by means of some sticky substance secreted by the knob. Capture was followed by penetration of the integument of the eelworm and the intrusion of a globular infection bulb, from which trophic hyphae grew out. The production of trophic hyphae was rather limited; usually only one or two were formed from each knob, possibly on account of the rather small size of the eelworms captured by this fungus. The trophic hyphae were mostly about 3 μ in diameter. The fungus continued to make vegetative growth over a long period; cultures 3 months old still showed plentiful mycelium, but in these older cultures the power of capturing eelworms was apparently lost, for although many knobs were formed, the eelworms seemed to be unaffected by them.

After a period of feeding, the fungus sporulated quite freely in nematode-containing cultures. The conidia were borne singly on erect conidiophores, mostly about 100 μ high, and sometimes the conidiophores branched near the apex, a conidium being formed at the end of each branch. The conidia were clavate, bluntly rounded at the distal end and tapering gradually to a point at the proximal end; they measured 25–44 × 6–9 μ, and were divided by one to four transverse septa. They germinated readily, usually producing on germination a short branch bearing an adhesive knob, by means of which an eelworm would be caught. Often a conidium would germinate from both ends simultaneously, frequently producing a stalked knob at one end while the other gave rise to a germ tube that developed directly into mycelium.

Pure cultures of the fungus were obtained by the usual technique of picking off conidia. Growth was moderately rapid on potato-carrot agar and sporulation was very abundant.

Dactyella asthenopaga closely resembles the somewhat larger *D. ellipsospora* (Preuss) Grove in its general organization (Grove, 1886; Drechsler, 1937), but the shape of its conidia marks it clearly as a separate species. The morphology and dimensions of the specimens that I have observed in this country agree very closely with the details given by Drechsler (1937).

Dactylella heterospora Drechsler in *Mycologia*, **35**, 347 (1943).

D. heterospora was found in June 1945, in a collection of rotting debris from a farmyard near Lowsonford, Warwickshire. It captured nematodes by means of constricting rings. Unfortunately, the amount of material available for observation was small, and the fungus failed to appear in subcultures.

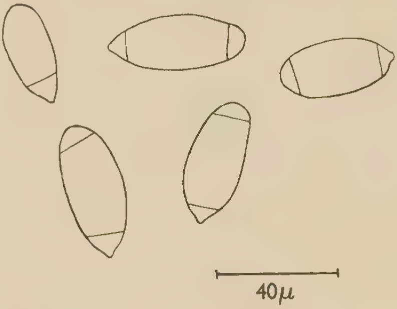

Fig. 4. *Dactylella heterospora* Drechsler. Conidia.

In its general morphology and method of capturing its prey, this fungus closely resembled *D. bembicoides* Drechsler (1937), which has already been recorded from the same locality (Duddington, 1946). The mycelium consisted of septate hyphae which, in the specimens I had under observation, were 2–4 μ wide. These bore at intervals stalked rings, made up of three somewhat curved cells, each one wider in the middle than at the ends. The stalk consisted usually of two cells. A nematode pushing its head into a ring was caught by constriction, the three cells of the ring swelling quickly to more than twice their original volume, just as in the similar traps formed by *D. bembicoides*. Capture was followed by invasion of the animal by trophic hyphae which grew out from the ring.

The principal difference between *D. heterospora* and *D. bembicoides* is in the shape of the conidia. In *D. heterospora* they were ellipsoidal in outline, and divided into three cells by a pair of cross-septa which were often somewhat oblique (Fig. 4). The central cell was much the largest. The conidia were 32–44 μ long and 15–19 μ wide, and were borne singly at the apices of erect conidiophores mostly about 300 μ high. Germination of the conidia was not observed.

The material that I had under observation did not appear to be forming the microconidia described by Drechsler (1943) for *D. heterospora*, nor did I see any of the resting bodies that he figures; the material available was very scanty, and it is quite possible that they might have been observed if it had been possible to maintain the fungus in culture for a longer time in order to get further observations. In other respects the fungus agreed well with Drechsler's description, and its identity does not appear to be in doubt.

Acrostalagmus obovatus Drechsler in *Phytopathology*, **30**, 784 (1941).

The occurrence of *A. obovatus* in Britain has already been briefly recorded (Duddington, 1950). It has been found in seven collections from different parts of the country: (1) in garden compost, near Kingston-on-Thames, Surrey, July 1937; (2) in leaf-mould, from an oakwood (*Quercetum roboris*) near Meriden, Warwickshire, May 1941; (3) in old cow dung from a derelict manure heap in a farmyard near Lowsonford, Warwickshire, May 1941; (4) in decaying stems of *Oenothera biennis* L. from under paving stones in a garden at Kew, Surrey, July 1948; (5) among bryophytes from a bank at the edge of a pasture near Marlborough, Devon, September 1948; (6) on rotting leaves of *Sedum Middendorffianum* Maxim., from a garden at Kew, Surrey, October 1948; and (7) in rotten wood from a garden compost heap near Kingston-on-Thames, Surrey, May 1949.

This fungus was internally parasitic in nematodes. The mycelium consisted of branched, septate hyphae about 2 μ in diameter, which ultimately filled the integument of the dead host, having absorbed its contents. From the internal mycelium fertile hyphae were given off as lateral branches which grew out from the carcass of the eelworm to a length of up to half a millimetre; they were usually about 2 μ in diameter, and were irregularly septate. The fertile hyphae bore at intervals flask-shaped phialides, 6–9 μ long and 2–3 μ wide, each with a short neck, less than 1 μ in diameter, at the apex of which spores were produced successively, cohering round the distal end of the phialide in groups of up to twenty. The spores were ovoid to subspherical, usually 2–3 μ long and 2 μ or rather less in diameter. The phialides were formed singly, in pairs, or in groups of three to eight on the fertile hyphae.

When a nematode was killed on or near the surface of the medium, the fertile hyphae were procumbent-ascending, but when, as often happened, the animal burrowed deep in the agar to die, the fertile hyphae tended to spread out horizontally.

Infection occurred through a spore adhering to the surface of an eelworm. As the spores were produced in large numbers, the chances of infection were high, especially in old cultures. Nematodes were frequently seen moving about actively with large numbers of spores sticking to their skins, especially near their anterior ends. The spores on germination penetrated the integument of the nematode with a germ tube which, inside the animal, grew into a hypha from which the branching mycelium was developed. Multiple infection was common.

Owing to the uncertain validity of the genus *Acrostalagmus*, the systematic position of *A. obovatus* is somewhat obscure.

Cephalosporium balanoides Drechsler in *Phytopathology*, **31**, 786 (1941)

C. balanoides was parasitic in nematodes in a collection of moss from a birchwood (*Betula pubescens* Ehrh.) on Box Hill, Surrey, October 1949. The collection was a mixture of *Eurynchium praelongum* B. & S. and *Thuidium tamariscinum* B. & S.

Infection of an eelworm occurred after a spore had stuck to the integument, a germ tube from the spore penetrating the cuticle and giving rise to a hypha within the animal. From this initial hypha a mycelium of branched, septate hyphae was developed; the individual hyphae were about 2 μ in diameter, and the mycelium continued to grow until it filled the body of the nematode. As the mycelium developed, the animal became more and more sluggish and finally died, its substance being gradually absorbed by the parasite until only the integument was left. In agar cultures containing nematodes, the fungus remained active for a long time, the epizoötic usually ending only when the agar medium had dried up.

When the mycelium was well established, fertile hyphae arose as lateral branches which emerged through the integument of the dead animal, and grew out into or over the substratum. When fully grown, these fertile hyphae reached a length of upwards of a millimetre, and were procumbent or somewhat ascending; they were usually about 2 μ in diameter, irregularly septate, and bore at intervals throughout their length elongated flask-shaped phialides from which the spores were produced. The phialides were 8–17 μ long, including a neck about 2 μ long, and 2–3 μ in greatest diameter. The spores were shaped like a 'bat's wing' Bunsen flame, mostly about 3 μ long and about 2·5 μ wide along the distal edge; each phialide produced in succession a number of spores, which tended to cohere in groups about the neck of the phialide, often giving the appearance of a Maltese cross when seen under the microscope (Fig. 5). The spores were produced in large numbers and, lying on the surface of the agar, were readily attached to casually passing eelworms, thus spreading the infection.

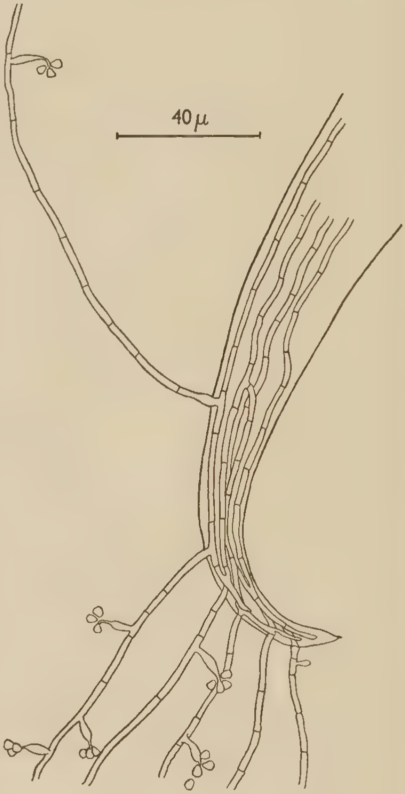

Fig. 5. *Cephalosporium balanoides* Drechsler. Posterior end of an infected nematode, showing internal mycelium, fertile hyphae, phialides and spores. Drawn from a preparation stained in cotton-blue and mounted in lactic acid.

The material that I had under observation agreed well with Drechsler's original description; a minor point of difference was the number of spores per phialide. Drechsler in his diagnosis states that five to fifteen spores are formed on each phialide, while those that I observed seldom produced more than five or six.

This species does not seem to fit happily into the form genus *Cephalosporium*, and it is probable that a revision of the taxonomic position of this and of the predacious species of *Acrostalagmus* will have to be undertaken at a later date.

Harposporium oxycoracum Drechsler in *Phytopathology*, **31**, 797 (1941).

This fungus was observed in September 1948, in a collection of bryophytes from a bank bordering a lane near Hatch Bridge, Devon, where it was internally parasitic in nematodes. The material was scanty, and the fungus failed to establish itself in subcultures; this may possibly have been due to competition with other predators, of which no less than six species were present in the same collection. It was, therefore, not possible to follow out in detail the life history of *H. oxycoracum*, but the observations that I was able to make agree in all important details with the description given by Drechsler (1941).

The mycelium of *H. oxycoracum* resembled that of the much more common *H. anguillulae* Lohde, the occurrence of which in Britain has been recorded in a previous communication (Duddington, 1946). Branched, septate hyphae, mostly 2–3 μ wide, filled the integuments of nematodes from which the contents had been absorbed. Fertile hyphae arose as lateral branches of the mycelium and grew out through the integument of the host; these were mostly 2–3 μ wide and often reached a length of nearly a millimetre. The fertile hyphae bore at intervals subspherical phialides, which were usually 3–4 μ in diameter, each having a single neck about 2 μ long and less than 1 μ wide.

Spores were produced in large numbers at the ends of the necks of the phialides. The spores were strongly curved, and measured 17–24 μ in a straight line from tip to tip and about 1 μ wide. At the proximal end of the spore was a small knob, which was surrounded by what appeared to be a droplet of viscous fluid. The distal end of the spore was sharply pointed; Drechsler (1941) suggests that this pointed tip may possibly assist the attachment of the spore to a nematode by penetrating the integument, assisted perhaps by contact with the conidiophore itself, as suggested by Kostka (1928) for *H. anguillulae*.

Nematoctonus tylosporus Drechsler in *Phytopathology*, **31**, 779 (1941).

This fungus was obtained from two collections, as follows; (1) in moss, from Hatch Bridge, Devon, September 1948; and (2) in moss (*Dicranum scoparium* Hedw.) from chalk grassland, Box Hill, Surrey, October 1949. Unfortunately the material from both collections was rather scanty.

The mycelium consisted of branched, septate hyphae, 2–3 μ wide, within the body of a nematode. Fertile hyphae, about 2 μ wide, were extruded through the integument of the dead host, and grew over the surface of the substratum to a length of a millimetre or more. Short lateral sterigmata on the fertile hyphae bore fusiform conidia, mostly about 20 μ long and 2–3 μ wide at the widest part, which was proximal. At the narrow distal end the conidium bore a small knob which, according to Drechsler (1941), is adhesive. Sometimes this knob was replaced by a short process, probably formed by premature germination, which Drechsler describes as highly adhesive.

By means of either the knobs or the apical processes, the conidia appeared to stick to the integument of a passing nematode. On germination of the conidium, the integument of the animal was penetrated, the penetration tube giving rise to the vegetative mycelium inside the host.

In addition to the conidia, the fertile hyphae sometimes bore, among the conidia, ovoid spore-like bodies, usually 8–10 μ long and about 4 μ wide. Drechsler suggests that these may be resting spores. I have never seen them germinate, nor did they appear to become attached to nematodes. They were faintly yellow in colour, and had a somewhat roughened wall.

An interesting feature of this fungus was the formation on the fertile hyphae of clamp connexions, suggesting that it is an imperfect basidiomycete.

Spicaria coccospora Drechsler in *Phytopathology*, **31**, 787 (1941).

S. coccospora occurred in a collection of moss from a bank at the edge of a pasture near Marlborough, Devon, September 1948. Only one specimen was observed, and the fungus failed to appear in subculture, so that the details available are unfortunately scanty.

The fungus was internally parasitic in a nematode. The mycelium resembled that of *Acrostalagmus obovatus*, consisting of branched, septate hyphae filling the body of the host. These vegetative hyphae were mostly 2–3 μ wide. The fertile hyphae emerged through the integument of the nematode; they rose erect to a height of about 100 μ, bearing at intervals whorls of flask-shaped phialides which were usually about 8 μ long and about 2 μ wide at the widest point. The phialides bore distally chains of conidia, which were almost spherical, and 1–2 μ in diameter.

This fungus is placed by Drechsler in *Spicaria* Auct., but as the validity of the genus is doubtful, a revision may be necessary at a later date.

B. ZOOPAGACEAE

Acaulopage baculispora Drechsler in *Mycologia*, **40**, 93 (1948).

A. baculispora occurred in a collection of bryophytes from the gardens of the Royal Horticultural Society at Wisley, Surrey, in October 1948.

The mycelium consisted of sparingly branched, non-septate hyphae, 1–2 μ in diameter. Amoebae were captured, apparently by adhesion to the hyphae, though as no adhesive material could be observed, the manner of attachment was a matter of conjecture only. Shortly after an amoeba became attached to the mycelium, the fungus produced haustoria which entered the animal, branched dichotomously within it and absorbed its contents. As in other members of the Zoopagaceae, absorption of the endoplasm of the amoeba continued until only the remains of the ectoplasm were left attached to the mycelium. The haustorial filaments were 1–2 μ in diameter, and the haustorium often appeared to be carried on a short pedicel of diameter somewhat less than that of the parent hypha.

The fungus sporulated freely in cultures containing amoebae. The conidia were filiform, standing erect on very short sterigmata, from which they were easily separated by mechanical disturbance. They were 39–66 μ long, 1–2 μ in diameter, and completely filled with cytoplasm, without any of the empty appendages that often occur in conidia of the genus *Acaulopage*. Sexual reproduction was not observed.

Acaulopage ischnospora Drechsler in *Mycologia*, **39**, 268 (1947)

This fungus was obtained from a collection of bryophytes from a bank bordering a lane near Hatch Bridge, Devon, September 1948.

In most of its characters, *A. ischnospora* closely resembled *A. baculispora*. The mycelium consisted of non-septate hyphae, 1–2 μ in diameter, and sparingly branched. Amoebae were captured apparently by adhesion to the mycelium, capture being followed by the intrusion of haustoria into the endoplasm of the animal. The haustoria resembled those of *A. baculispora*; they were of about the same diameter as the vegetative hyphae, dichotomously branched and borne on a short, rather narrow pedicel.

The conidia of *A. ischnospora* were filiform, 30–110 μ long and 1–2 μ in diameter (Fig. 6*a*). The conidia that I observed appeared to be completely filled with cytoplasm without the distal empty appendage described by Drechsler for this species. They stood erect while attached to the mycelium, though they tended to bend over somewhat owing to their great length. As in *A. baculispora*, they were borne on short lateral sterigmata projecting from the vegetative hyphae.

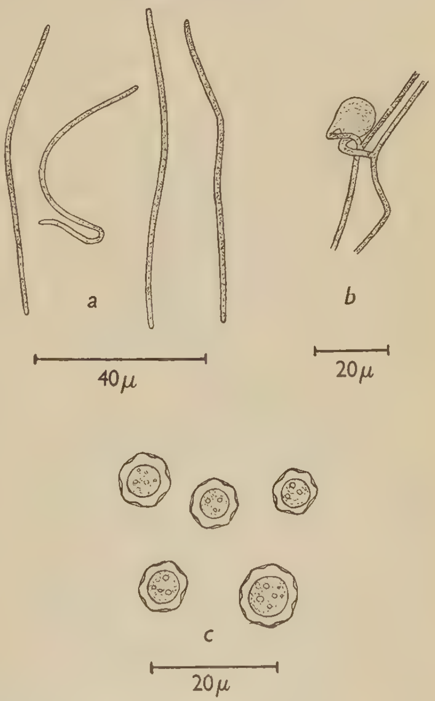

Fig. 6. *Acaulopage ischnospora* Drechsler, drawn from preparations stained in cotton-blue and mounted in lactic acid. *a*, conidia; *b*, early stage in fusion of gametangia; *c*, zygospores.

Sexual reproduction took place by the union of pairs of similar gametangia. The copulation branches were somewhat flexuous, and commonly twisted round one another for about half a turn before fusion (Fig. 6*b*). Often conjugation took place between a copulation branch arising from the mycelium and one from the germ hypha of a conidium. The zygospores measured 6–9 μ in external and 4–6 μ in internal diameter, their walls being ornamented by a number of bullate protuberances of which five to eight were visible in profile. The zygospore was contained in a thin-walled zygosporangium, which at maturity collapsed closely around the wall of the zygospore (Fig. 6*c*).

The material that I had under observation agreed well with the description of *A. ischnospora* given by Drechsler (1947) except in the absence of any empty tips to the conidia. The erection of a new species on account of such a small difference does not seem desirable, so the fungus here described is provisionally identified as *A. ischnospora* Drechsler.

Stylopage rhicnacra Drechsler in *Mycologia*, **40**, 102 (1948).

This fungus occurred capturing amoebae in a collection of bryophytes of various species from a bank at the edge of a field near Marlborough, Devon, in September 1948.

Eleven days after sterile plates of maize-meal agar had been inoculated with small pieces of the bryophyte material with particles of soil adhering, a system of delicate hyphae was observed growing out from the inoculum and capturing amoebae in the usual manner of the Zoopagaceae. The hyphae were non-septate and 1–2 μ in diameter. The amoebae appeared to be captured by adhesion to the hyphae, but whether any sticky substance was actually involved, or whether the amoebae had merely placed themselves alongside the hyphae as these animals often do, could not be determined.

Capture of an amoeba was followed by the development of haustoria within the animal. The haustoria were filamentous, not much branched, all originating at the same point on the subtending hypha and spreading in a bush-like manner throughout the endoplasm of the amoeba (Fig. 7*a*). The filaments of the haustoria were very fine; usually they were not more than 1 μ in diameter. Consumption of the contents of the amoeba followed in the usual way, so that eventually only the remains of the ectoplasm remained attached to the mycelium.

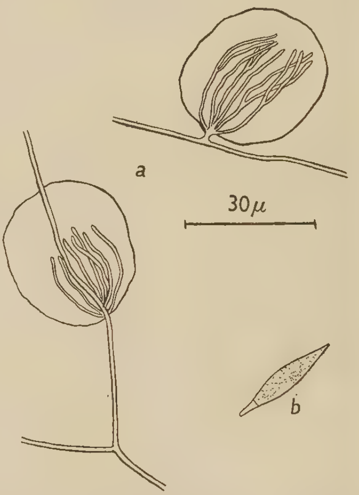

Fig. 7. *Stylopage rhicnacra* Drechsler, drawn from preparations stained in cotton-blue and mounted in lactic acid. *a*, two portions of mycelium, with captured amoebae and haustoria; *b*, conidium.

Conidia were produced in large numbers as the mycelium grew older; as is usual in the Zoopagaceae, sporulation was preceded by a period of predacious activity, and when once the formation of spores was well under way capture of amoebae ceased, at least by the part of the mycelium concerned in spore production. The conidiophores were very long, almost comparable in their length with those of *Stylopage hadra* (Drechsler, 1936;

Duddington, 1940) and *S. rhynchospora* (Drechsler, 1939; Duddington, 1951). They rose to a height of 60–105 μ above the substratum, each conidiophore bearing at its apex a single conidium. The conidia were broadly fusiform, pointed at the proximal end and bearing at the distal end an empty appendage (Fig. 7*b*). The dimensions of the conidia without appendages were 22–30 μ × 5–6 μ, and the appendages were 3–9 μ long. These appendages were clearly visible when the living fungus was examined by means of a dry objective, but when mounted in lactic acid-cotton blue they were almost invisible owing to their transparency and lack of differential refraction. Although conidia were produced in large numbers, I did not on any occasion observe the production of a secondary conidium by the germination of a primary one. This is in agreement with Drechsler (1948).

No gametangia or zygospores were observed in connexion with this fungus, although cultures containing it were under observation for several weeks; Drechsler (1948) also reports that he did not observe zygospore formation by *S. rhicnacra*.

Zoopage thamnospira Drechsler in *Mycologia*, **30**, 142 (1938).

This species was found capturing nematodes in two collections of decaying organic matter from a garden at Kew, Surrey, July 1948. These were: (1) rotting fragments of *Achillea millefolium* L. from beneath a paving stone; (2) part of a decaying plasmodium of *Fuligo septica* Gmelin.

Small portions of both collections were placed on plates of sterile maize-meal agar and left to develop at room temperature. On examining the cultures a fortnight later, they were found well covered with amoebae, many of which were being captured by *Zoopage thamnospira*.

The mycelium consisted of delicate non-septate hyphae, 1–2 μ in diameter, containing cytoplasm which, as in many of the Zoopagaceae, was highly vacuolated. Amoebae were captured, apparently by adhesion, and were then invaded by an extensive haustorial system. These haustoria were long, branched, somewhat greater in diameter than the vegetative hyphae, and usually coiled, resembling at first glance the thallus of a *Cochlonema* (Fig. 8*a*). The coiling of the haustoria, together with their relatively large diameter, makes this fungus easy to recognize.

Conidia were produced in chains, each chain arising from a short lateral process from the mycelium. The conidia were fusiform, smooth-walled, measuring 7–30 × 2–3 (4) μ (Fig. 8*b*). The chains were fairly easily disrupted, leaving the conidia scattered about the surface of the culture medium in great numbers.

In addition to the conidia, a number of zygospores were observed associated with the mycelium. Unfortunately, it was not possible to establish with absolute certainty organic connexion between these and the fungus under discussion, but they occurred always together, and, as the zygospores were of the very characteristic type found in the Zoopagaceae, it seems possible that they were the zygospores of *Zoopage thamnospira*. The zygospores were spherical, 4–6 μ in internal diameter, 6–8 μ in external diameter, the zygospore wall being decorated with a number of warty protuberances, of which six to ten were visible in profile. The wall of the zygosporangium could be seen collapsed about the bullae (Fig. 8*c*).

The fungus here described as *Z. thamnospira* differs somewhat from the description given by Drechsler (1938). Some of the conidia that I measured were wider than Drechsler's maximum, his range being 8–25 × 1·5–2·6 μ. All the conidia that I examined had smooth walls, whereas Drechsler describes the wall of the conidium as 'minutely but distinctly verrucose'. The haustoria that I observed did not have the forked empty apical appendages that he describes, and he does not record the finding of any zygospores. In spite of these differences, however, it does not seem desirable at present to erect a new species, especially as observation of other species of *Zoopage* has

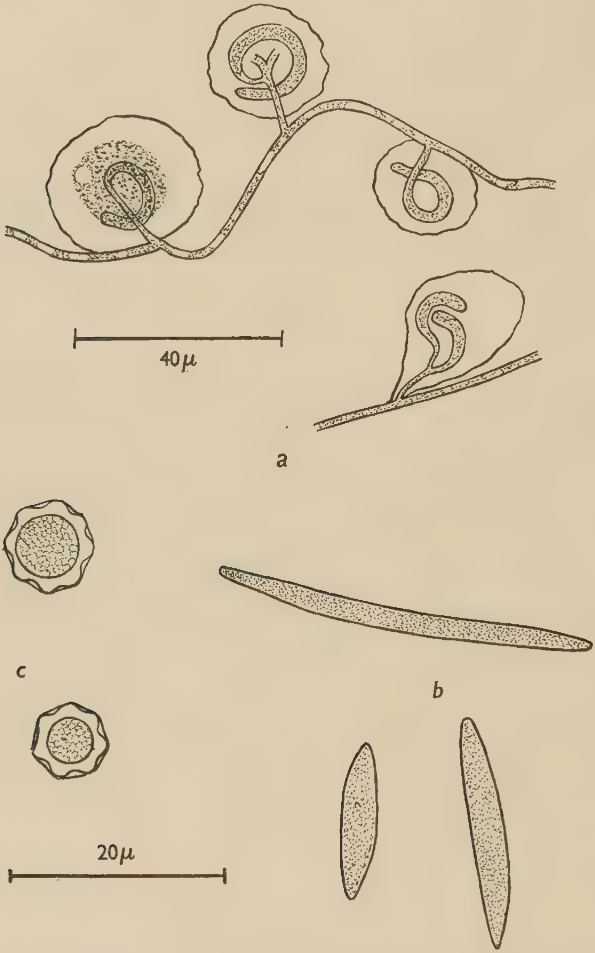

Fig. 8. *Zoopage thamnospira* Drechsler, drawn from preparations stained with cotton-blue and mounted in lactic acid. *a*, two portions of mycelium, with captured amoebae and haustoria; *b*, conidia; *c*, zygospores associated with the fungus.

made it clear that this is a rather labile genus, the species often departing somewhat from type.

In making measurements and preparing the drawings used in this work, living material mounted in water has been used, unless otherwise stated.

I should like to express my thanks to Mr R. A. Gillanders for assistance in preparing the Latin diagnosis, to Mr F. Rose for help in identifying mosses, to my colleagues, Mrs Mary Peach and Mr F. R. Browning, for advice on various matters, and especially to Dr B. Barnes, not only for providing me with the collections from Kew, but also for his invaluable help throughout the work.

The material here set out has formed part of a thesis for the Ph.D. degree in the University of London.

REFERENCES

ARMITAGE, F. D. (1945). Chlorazol black E as a stain for mycological specimens. *Trans. Brit. mycol. Soc.* **27**, 131–133.

DRECHSLER, C. (1936). A new species of *Stylopage* preying on nematodes. *Mycologia*, **28**, 241–246.

DRECHSLER, C. (1937). Some hyphomycetes that prey on free-living terricolous nematodes. *Mycologia*, **29**, 447–552.

DRECHSLER, C. (1938). New Zoopagaceae capturing and consuming soil amoebae. *Mycologia*, **30**, 137–157.

DRECHSLER, C. (1939). Five new Zoopagaceae destructive to rhizopods and nematodes. *Mycologia*, **31**, 388–415.

DRECHSLER, C. (1941). Some hyphomycetes parasitic on free-living terricolous nematodes. *Phytopathology*, **31**, 772–802.

DRECHSLER, C. (1943). A new nematode-capturing *Dactylella* and several related hyphomycetes. *Mycologia*, **35**, 339–362.

DRECHSLER, C. (1947). Three zoopagaceous fungi that capture and consume soil-inhabiting rhizopods. *Mycologia*, **39**, 253–281.

DRECHSLER, C. (1948). Three Zoopagaceae that subsist by capturing soil amoebae. *Mycologia*, **40**, 85–105.

DUDDINGTON, C. L. (1940). Predacious fungi from Cotswold leaf-mould. *Nature, Lond.*, **144**, 150–151.

DUDDINGTON, C. L. (1946). Predacious fungi in Britain. *Trans. Brit. mycol. Soc.* **29**, 170.

DUDDINGTON, C. L. (1950). Predacious fungi. *J. Quekett micr. Cl.* (ser. 3), **2**, 67–88.

DUDDINGTON, C. L. (1951). Further records of British predacious fungi. I. *Trans. Brit. mycol. Soc.* **33**, 209–214.

GROVE, W. B. (1886). New or noteworthy fungi. Part 3. *J. Bot., Lond.*, **34**, 129–137, 197–206.

KOSTKA, C. (1928). Nematodenfangende Pilze. *Mikrocosmos*, **21**, 151–156.

ZOPF, W. (1888). Zur Kenntnis der Infections-Krankheiten niederer Thiere und Pflanzen. *Nova Acta Leop. Carol.* **52**, 314–376.

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AQUATIC ASCOMYCETES: *CERIOSPORA CAUDAE-SUIS* N.SP. AND *OPHIOBOLUS TYPHAE*

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(With Plate 7 and 3 Text-figures)

An account is given of an aquatic lignicolous pyrenomycete (*Ceriospora caudae-suis* n.sp.) with an oval two-celled ascospore bearing coiled persistent mucilaginous appendages at each pole. The tendency of the ascus to break into an upper and a lower half is discussed and this is compared with what happens during spore discharge in another aquatic species, namely *Ophiobolus typhae* Feltg.

Ceriospora caudae-suis sp.nov.

Perithecium nigrum, immersum, oblongum (0·4–0·7 mm. × 0·3–0·5 mm.) brevi cervice. Ascus cylindratus (circa 300 μ longus, 18 μ latus) sed ima parte in angustum caulem attenuata, habens in apice foramen, uniseriatus octosporus. Ascospora pallida lutea, oblonga (32 μ × 15 μ), uniseptata, cum multis guttis olei et simplici in utroque termino appendice gelatinosa. Appendix gelatinosa prope basim recta et 2–3 μ lata, sed prope apicem contorta et minus quam 1 μ lata, 50–120 μ longa. Paraphyses simplices, septatae, hyalinae, 150–200 μ longae, 5–6 μ latae prope basim et 3–4 μ latae prope apicem.

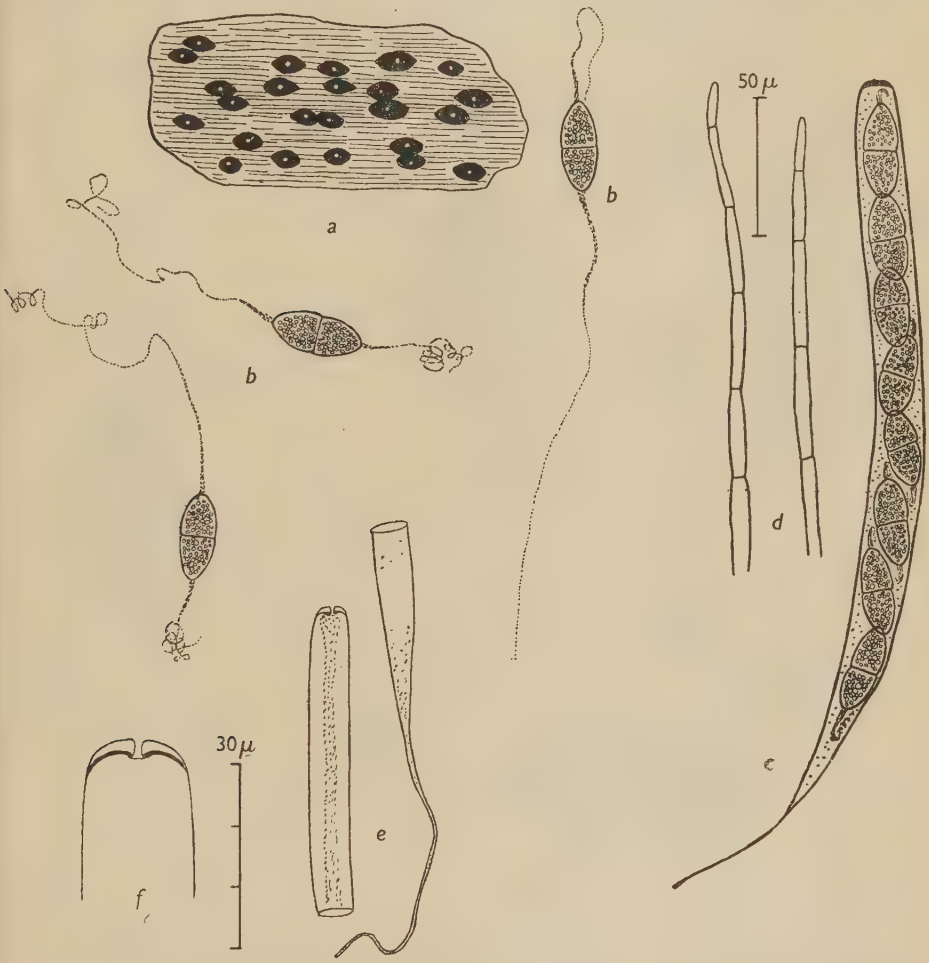
Hab. In submerso ligno Fraxini ex Windermere, Westmorland, Anglia.

Perithecium black, immersed, oblong (0·4–0·7 × 0·3–0·5 mm.) with a short neck. Ascus cylindrical (about 300 μ long × 18 μ broad) but with the base attenuated to form a narrow stalk, with an apical pore, uniseriately 8-spored. Ascospore pale yellow, oval (32 μ × 15 μ), 1-septate, with numerous oil drops, with a simple gelatinous appendage at each end. Gelatinous appendage straight near base and 2–3 μ broad but coiled towards the apex and less than 1 μ broad, 50 μ–120 μ long. Paraphyses simple, septate, colourless, 150–200 μ long, 5–6 μ broad near base and 3–4 μ broad near apex. On submerged wood of *Fraxinus* from Windermere, Westmorland, England.

The first fungus described in this paper was found on decorticated twigs and small branches of ash dredged from a depth of 3–5 ft. in Lake Windermere, close to Wray Castle. The healthy condition of the fungus showed unmistakably that is was growing under normal conditions, and its woody substratum had clearly been submerged for a considerable time. The species has been collected from the same locality on three occasions, in June 1948, in August 1949 and in November 1949.

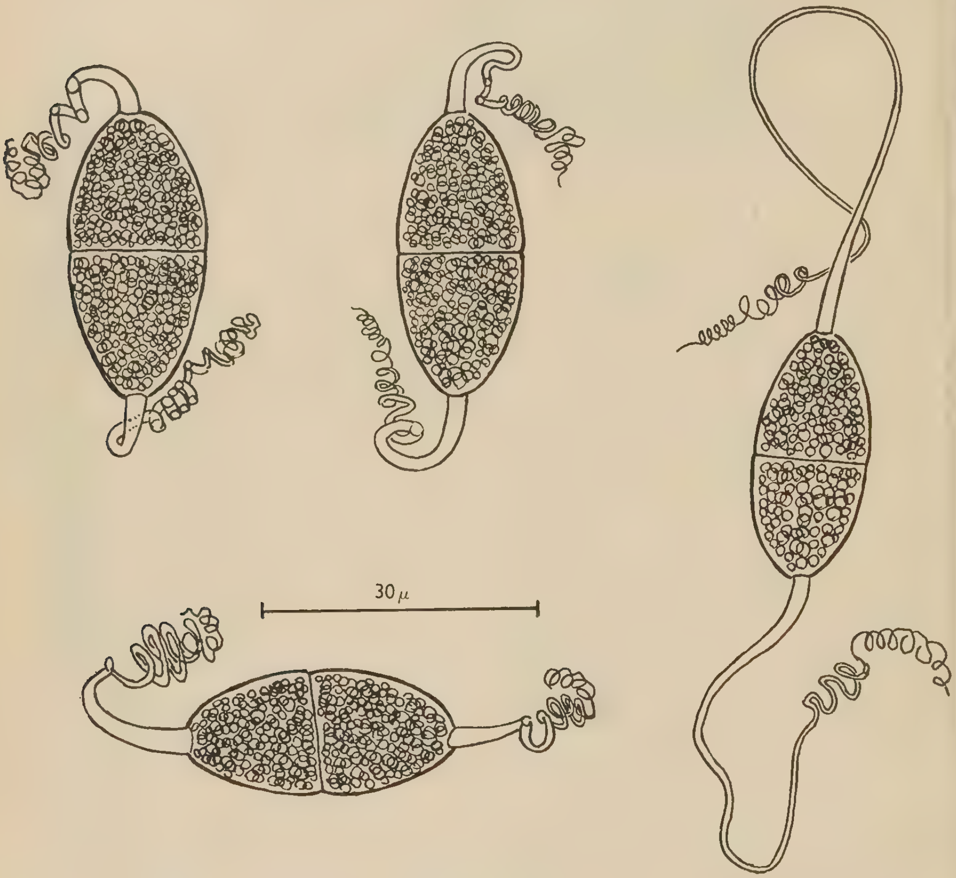
The perithecia occur gregariously (Text-fig. 1 *a*) in the outer layers of the wood and each, in surface view, is broadly naviculoid due to elongation in the direction of the grain of the wood. In some of the twigs that were examined the outer fibres of the wood had rotted away leaving the perithecia partially exposed, but mostly the round ostiole, situated at the end of a very small neck (Pl. 7*a*), is the only part of the perithecium to reach the outside.

Within the perithecium are numerous asci and a few paraphyses. Each paraphysis is colourless, simple, septate and tapers gradually from base to apex (Text-fig. 1*d*). The ascus is long and narrow. The upper part, containing the spores, is cylindrical, but below the spores it is constricted to form a stalk which may be quite long (Text-fig. 1*c*). The apex of the ascus is somewhat thickened and furnished with a clearly defined pore (Text-fig. 1*f*). Within the ascus, forming a single row, are eight oval spores each divided by a transverse wall into two equal cells crowded with very

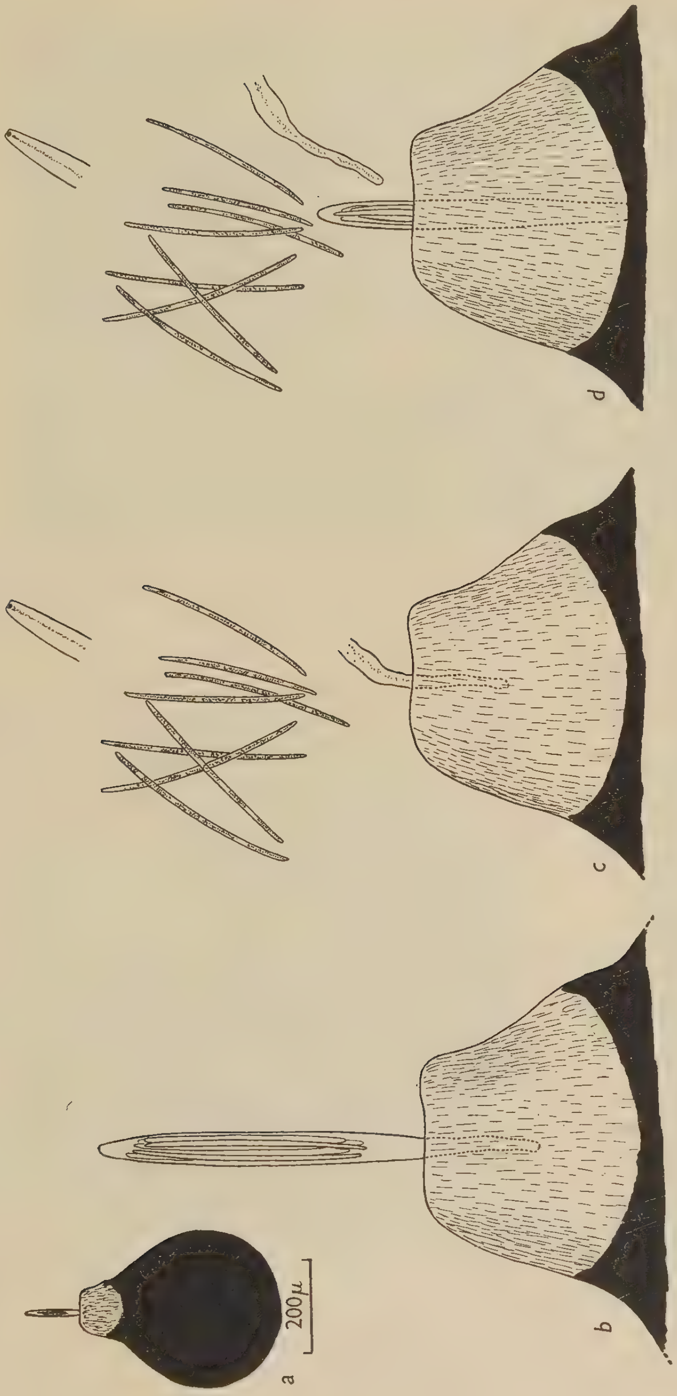


Text-fig. 1. *Ceriospora caudae-suis* n.sp. *a*, sliver from submerged ash twig showing perithecia in surface view; *b*, ascospores with their appendages somewhat uncoiled; *c*, ascus; *d*, paraphyses; *e*, upper and lower halves of an ascus after rupture; *f*, tip of ascus showing pore. All from living material collected in Windermere. *a*, × 15; *b–e*, all at same magnification given by scale between the paraphyses; *f*, more highly magnified.

numerous oil globules giving the whole spore a pale yellow tint. Attached to each pole of the ascospore is a remarkable appendage of firm mucilage. This is a simple strand which near its attachment to the spore is 2–3 μ broad and more or less straight, but tapers to less than 1 μ towards its free end and is tightly coiled (Text-fig. 2). Occasionally in liberated spores this coiled part becomes more or less straightened and then its total length may be seen to exceed 100 μ (Text-fig. 1 *b*). Within the ascus the coiled parts of the appendages are bent towards the equator of the spore, so that the appendages of neighbouring spores do not become intertwined and on liberation are quite free from one another. This behaviour is very different from that of the long mucilaginous strands in *Sordaria* spp. (e.g. *S. fimiseda* Ces. & de Not. and *S. curvula* de Bary) which rope the eight ascospores together into a single spore-mass. The mucilaginous appendages in *Ceriospora caudae-suis* are very persistent and, even after germination has occurred and a stout germ-tube has been produced from each pole of the spore, can still be seen but displaced to the side.



Text-fig. 2. *Ceriospora caudae-suis* n.sp. Ascospores. From Windermere material.



Text-fig. 3. *Ophiobolus typhae* Feltg. Spore discharge. A single perithecium is shown at a lower power (*a*) and the neck region more highly magnified (*b*). *b*, *c* and *d* show stages in the process. A few seconds elapsed between *b* and *d*.

I have not succeeded in seeing the emergence of asci through the ostiole of the perithecium, so the mode of spore liberation remains in doubt. However, it seems unlikely that the ascospores escape through the apical pore of the ascus. When a perithecium is crushed under a cover-slip in water, most of the ripe asci are found to have ruptured and in a very characteristic manner. Apparently there is a transverse line of weakness about the middle of the ascus so that it readily breaks into an upper and a lower part (Text-fig. 1*e*). The upper ascus halves are persistent, have relatively thick walls and are a conspicuous feature in a preparation of a crushed perithecium. The lower halves, however, have much thinner walls and soon disintegrate completely. It seems very likely that spore-discharge in this fungus is of the same type as that observed in *Ophiobolus typhae* Feltg. which is described below.

The fungus has been grown in single-spore pure culture on 2% malt agar. It grows very slowly, forming an extremely compact dark-grey colony, black when viewed in reverse, with aerial growth less than 0·5 mm. high. For the first 3 months in culture at laboratory temperature in the light, the colony fails to form any spores. Even when slices of the culture are immersed in water, no conidial stage is developed. At the end of 4 months, the colonies being then approximately 2 cm. in diameter, single-spore cultures produce abundant perithecia. These are densely gregarious, black, brittle, almost spherical, usually without any neck and contain paraphyses and asci with ascospores exactly like those in the perithecia found in nature.

This fungus appears to be referable to the genus *Ceriospora*, although it differs from all other known species of that genus in the length of the mucilaginous appendages and in their coiling. The specific epithet '*caudae-suis*' is proposed because of the resemblance of the appendages to the tails of pigs.

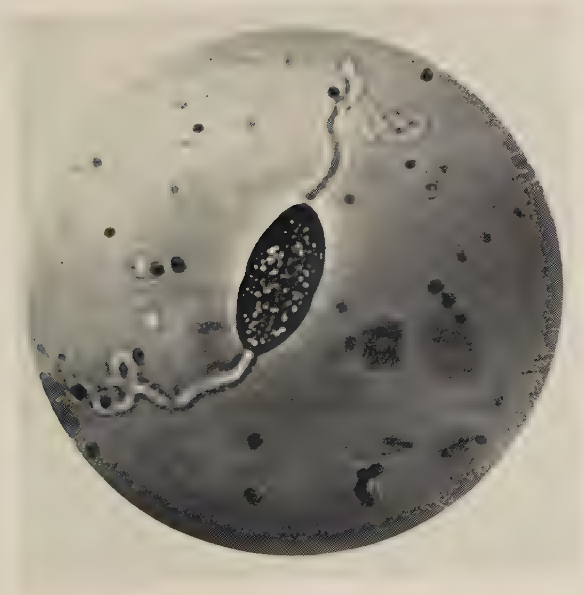
A culture of this fungus has been sent to the Commonwealth Collection of Fungus Cultures, and there is also material deposited at the Commonwealth Mycological Institute as *Ceriospora* sp. (Herb. I.M.I. No. 38506).

Ophiobolus typhae Feltg., *with special reference to spore discharge*

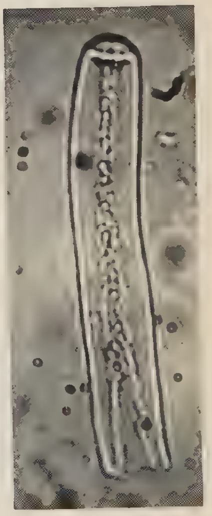
In October 1949 I found a species of *Ophiobolus* growing completely submerged on dead, but still attached, leaf bases of *Typha latifolia* in Wisley Pool, Surrey. The level of the Pool was exceptionally low, and there was no doubt that the perithecia of the fungus must have been submerged throughout their existence. Since *Ophiobolus typhae* is the only species of the genus described on *Typha* and since the spore measurements of the material from Wisley Pool agree well with those given by Feltgen, it seems reasonable to identify this species as *Ophiobolus typhae*, in spite of the fact that the original description is somewhat inadequate. Freshly liberated ascospores of the Wisley material have a length of 97 μ (the average of twenty spores selected at random), a breadth of 2 μ and have three or four septa which, however, are very difficult to see in the living spores.

The perithecia, which have black though rather soft walls, are immersed in the tissue of the dead leaf-base and only the extreme tip of the short neck emerges. If an individual perithecium is carefully dissected away from its

a



b



c

substratum and mounted in water on a slide, spore discharge can readily be seen. Observation is helped by the fact that the neck region is pale in colour and more or less transparent so that the passage of the ascus up the neck-canal can be watched. Spore liberation is illustrated in Text-fig. 3. An ascus passes slowly up the neck-canal and emerges through the ostiole until the spore-containing part is quite outside the perithecium. It then bursts along a transverse line of weakness near the middle of the ascus and the eight filiform spores are set free. The lower half of the ascus is still held by its base in the ostiole, but is soon dislodged by the next ascus pushing up from below. Occasionally an unripe ascus appears at the ostiole and is then pushed out without liberating its spores. The interval between the discharge of successive asci varies, at laboratory temperature, from 2 to 5 min.

The deposit that accumulates outside the ostiole consists of top and bottom halves of asci, filiform spores and occasional unripe asci. The top halves of the burst asci have relatively thick walls and are persistent, but the bottom halves have much thinner walls and very soon disintegrate. The half-asci of *Ophiobolus typhae* are very like those to be seen when a perithecium of *Ceriospora caudae-suis* is crushed under a cover-slip, and it seems likely that the method of spore liberation is similar in both species. This would suggest that in these fungi the ascus no longer dehisces by its apical pore but has developed a new mechanism.

A sample of my material of *Ophiobolus typhae* has been deposited at the Commonwealth Mycological Institute (Herb. I.M.I. No. 38060).

My best thanks are due to Mrs J. Lund who first collected *Ceriospora caudae-suis* in Windermere and brought it to my attention, to Mr H. C. Gilson who kindly allowed me to work in the laboratories of Wray Castle during August 1949, to Miss E. M. Rosser for preparing the section of the perithecium shown in Pl. 7, to Dr M. B. Ellis for examining both the fungi discussed in this paper and for giving me advice on their taxonomy, and to Prof. E. H. Warmington for help with the Latin diagnosis.

EXPLANATION OF PLATE 7

a, longitudinal section of perithecium growing on submerged ash wood, × 124; *b*, ascospore, × 720; *c*, upper half of an ascus in a mount of a crushed perithecium, × 580. *b* and *c* from pure culture.

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HYPOGAEOUS FUNGI. I.

A HYPOGAEOUS GASTEROMYCETE, *SCLEROGASTER MACROSPORUS* N.SP.

By LILIAN E. HAWKER
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(With 1 Text-figure)

Three collections of a hitherto undescribed hypogaeous Gasteromycete have been made in Westridge Wood, a beech wood on the Cotswold hills near Wotton-under-Edge, Gloucestershire.

The first collection was made by Miss J. Fraymouth, on 31 December 1949, and comprised three specimens. One of these was relatively large (2·5 × 1·8 × 1·8 cm.), and was partially disintegrated. Another was smaller (1·0 cm. in diameter) but was already mature. The larger specimen was found on the surface of the soil by a path and may have been dropped by an animal. The smaller specimen was lying on the surface of a clay soil covered with partially decayed wet leaves. Both these specimens were too old to be of use in determining the method of spore formation. The third specimen was very small (3–4 mm. diameter) and no spores had developed. It was almost certainly a young fruit-body of the same species. Parts of these specimens were sent under the reference number J.F. 7 to the Herbarium of the Royal Botanic Gardens, Kew, and were later renumbered H 51.

The second collection, on 25 February 1950, comprised a single young fruit-body found embedded in deep humus in a patch of *Neottia nidus-avis* near the bottom of a steep slope in the same beech wood as the first collection, but some distance away from it. This specimen showed developing basidia and the figures were made from it.

The third collection, on 4 April 1950, comprised two small specimens (1·0–1·2 cm. diameter), in one of which the spores were still attached to the basidia. These specimens were found in the same wood at some distance from the two previous collections. They were at a depth of about 1 in., in a shallow layer of soil overlying a hard pan of clay, and covered with a thin layer of moss. Young fruit-bodies had no odour, older ones had a rancid smell.

All the specimens were more or less spherical and attached at the base to a poorly developed, whitish, mycelial strand from which they readily become detached, leaving a small basal depression. The mycelium was not obvious in the surrounding soil.

The peridium is dirty white, thin, wrinkled, intact in young specimens but splitting to show the gleba in older specimens. Although thin and liable to split, the peridium is not readily separable from the gleba. In young specimens the gleba is pinkish purple, in older ones brownish purple. The cavities are small, numerous and air-filled. They develop first in the centre of the gleba often leaving peripheral pockets of immature cavities (Fig. 1 A). Such a pocket may be situated at the base of the fruit-body, but this is not a constant feature and disappears in old specimens, in which the whole of the gleba is differentiated. The hymenium lining the cavities consists first of crowded, short, club-shaped basidia. These elongate and project above the general level of the hymenium as the spores develop, (Fig. 1 B–I). The basidia are two-spored, forking at the top to give two blunt conical branches or sterigmata to which the spores are attached. The spores are shed into the cavity before they are fully ripe and the basidia rapidly shrivel and disappear. The spores are at first colourless, smooth, thin-walled and pear-shaped, becoming golden-brown, thick-walled and more or less spherical (13–18 μ diameter) with a colourless papilla at the point of attachment to the basidium. The walls may be described as shallowly and irregularly reticulate or irregularly dimpled (Fig. 1 J–N).

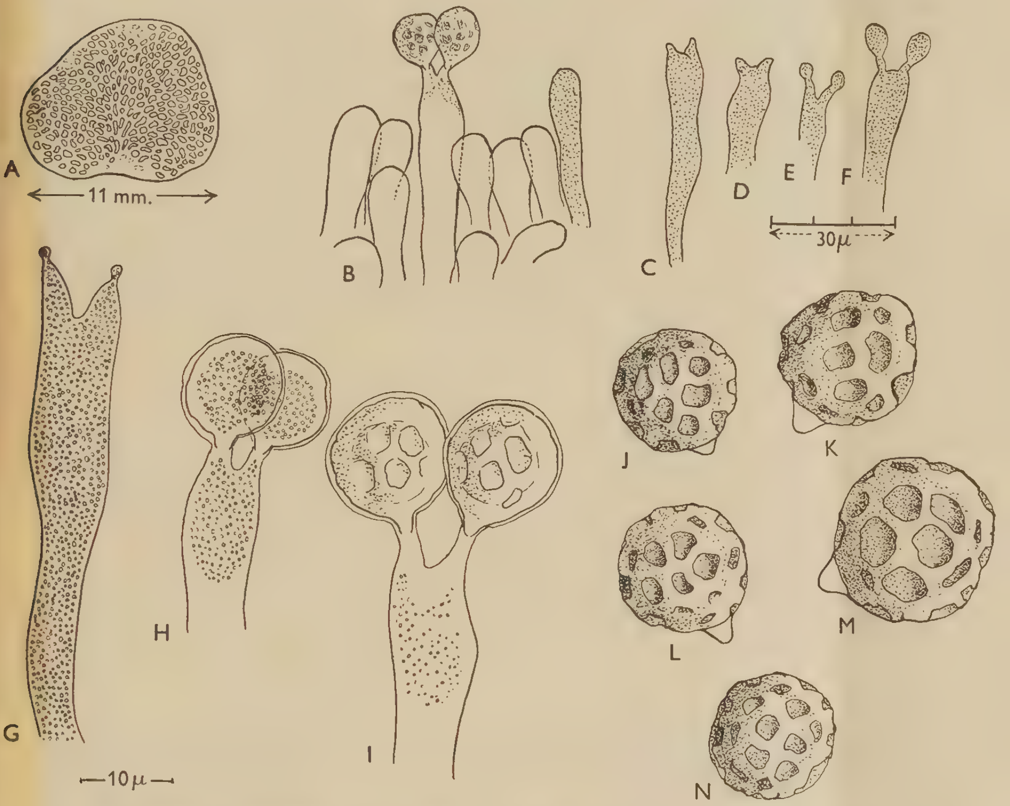

Fig. 1. *Sclerogaster macrosporus* Hawker n.sp. A, longitudinal section of fruit-body showing cavities and peripheral areas (including the base) in which these are not fully formed, × 2¼; B, part of young hymenium showing young basidia and one nearly mature one, × 550; C–F, developing basidia, × 550; G–I, developing basidia, × 1150; J–N, mature spores, × 1150.

No published description of any species with these distinctive spores has been found and there are no comparable specimens in the Kew Herbarium.

The general external features and morphology of the fruit-body are similar to those of some species of *Hymenogaster*, but the shape and sculpturing of the basidiospores is not paralleled in this genus. It has already been pointed out that the peridium, although thin, is entire in young specimens so that the species cannot be assigned to *Gautieria*. The sterile base occasionally present in young specimens does not persist as in *Octaviania*. The latter genus, moreover, has been dropped by Zeller and Dodge (1934, 1935, 1936*a b*) owing to the dubious nature of some of the type material. They transferred *O. asterosperma* to the genus *Arcangeliella*, but the absence of lactiferous ducts excludes the present specimens. The frequent presence of the sterile base in young specimens, together with the reticulate or pitted sculpturing of the basidiospore walls, also excludes the present species from *Hydnangium*, according to Zeller and Dodge's definition of this genus, while the absence of a true columella prevents its inclusion in *Elasmomyces*. It may best be placed in *Sclerogaster*, although the thin peridium and relatively large spores are not typical of this genus. Nevertheless, the criteria used to separate the genera of hypogaeous Gasteromycetes are of such an unsatisfactory nature that to add a new genus to the list would merely add to the existing confusion. It is proposed, therefore, that this species should be placed provisionally in the genus *Sclerogaster* as

Sclerogaster macrosporus Hawker sp.nov.

Sporophora irregularia, subglobosa, 0·5–2·5 cm. diam., e mycelio sparso funiformi oriunda, mox disjuncta. Peridium tenue, rugulosum, sordide albidum, makeritate fissum et glebam detegente sed difficiliter e gleba secedente. Gleba primo carnea, dein sporis maturescentibus purpureo-brunnea, loculis parvis, concavis, e centro ad externum formatis.

Basidia primo clavata, dein cylindracea et supra hymenium extantia, 50–70 × 5–9 μ, 2-sterigmatica. Sporae ex hyalinis aureo-brunneae, laeves, pyriformes, plus minusve sphaericae, papilla hyalina basali praeditae crasse tunicatae, episporio irregulariter scrobiculato, 13–18 μ diam.

Hab. in terra in fagetis, Wotton-under-Edge, Gloucestershire, England, 31 December 1949 (typus).

Fruit-bodies irregularly globose, 0·5–2·5 cm. diameter, attached to poorly developed mycelial strand at base, readily becoming detached. Peridium thin, wrinkled, dirty white, splitting when mature to show gleba, but not readily separable from gleba. Gleba flesh-coloured in young specimens, becoming brown-purple as spores ripen. Cavities small, numerous, air-filled, developing first in centre of gleba, whole gleba finally becoming differentiated.

Basidia at first club-shaped, then cylindrical and projecting above level of hymenium, 50–70 × 5–9 μ, 2-spored. Spores at first colourless, smooth, pear-shaped, becoming golden-brown, more or less spherical with colourless papilla at point of attachment to basidium, thick-walled, irregularly dimpled or pitted, 13–18 μ diameter.

At or near surface of soil in a beechwood, Wotton-under-Edge, Gloucestershire, England.

Type collection 31 December 1949 (H 51 (J.F. 7)). Material deposited in Herbarium of Royal Botanic Gardens, Kew and also in Department of

Botany, University of Bristol. Further collections, 25 February 1950 (H 71 (L.E.H. 27)), 4 April 1950 (H 97 (L.E.H. 33)).

Thanks are due to Miss J. Fraymouth who placed the material of the type collection at my disposal, and to Miss E. M. Wakefield of the Herbarium, Royal Botanic Gardens, Kew, for guidance in searching through the literature and the herbarium material and for the Latin diagnosis.

REFERENCES

Zeller, S. M. & Dodge, C. W. (1934). *Hymenogaster* and related genera. *Ann. Mo. bot. Gdn*, **21**, 625.

Zeller, S. M. & Dodge, C. W. (1935). New species of Hydnangiaceae. *Ann. Mo. bot. Gdn*, **22**, 265.

Zeller, S. M. & Dodge, C. W. (1936*a*). *Hydnangium* and related genera. *Ann. Mo. bot. Gdn*, **23**, 565.

Zeller, S. M. & Dodge, C. W. (1936*b*). *Elasmomyces*, *Arcangeliella* and *Macowanites*. *Ann. Mo. bot. Gdn*, **23**, 599.

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WILT DISEASE OF *DIMORPHOTHECA BARBERIAE*

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(With 3 Text-figures)

A wilt of *Dimorphotheca barberiae*, observed in the Botanic Garden, Bristol, in 1949, is shown to be caused by *Fusarium lateritium* Nees. The wilt was reproduced by artificial inoculation and also in soil that had been naturally contaminated with the fungus for a year.

Occurrence and symptoms

In October 1949 a number of plants of *Dimorphotheca barberiae* Haw., growing in the Hiatt Baker Botanical Garden, University of Bristol, exhibited severe wilting symptoms. The roots of these plants were shrivelled and disintegrated when touched, the stems were blackened from the base upwards, and all but the youngest leaves were chlorotic and flaccid.

Sections of the roots and stems, stained with aniline blue in lactic acid or by Cartwright's method (Cartwright, 1929), showed fine septate hyphae in the vessels and tracheids. These hyphae were much branched and passed from one element to the next through lateral pits and the end walls of the vessels (Figs. 1, 2). In the roots hyphae were present only in the wood elements, but in the stems the pith was also penetrated.

Isolations made from surface-sterilized root and stem material all yielded the same fungus, a species of *Fusarium*.

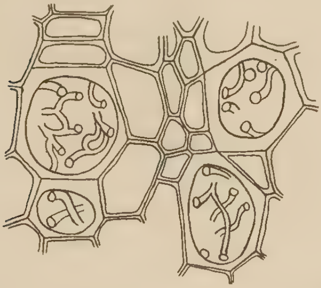

Fig. 1. Transverse-section of stem of diseased material showing hyphae in primary wood.

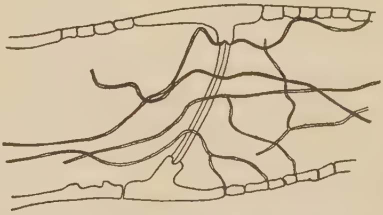

Fig. 2. Branched hyphae passing through pits and end walls of a vessel from stem material.

Morphology of isolate

A colony incubated in the dark at 25° C. on Czapek's agar completely fills a 9 cm. plate in 8 days. The surface of the colony is loosely floccose. At the periphery the turf is white and as deep as the plate, but at the centre it is crimson-yellow and 4–6 cm. in depth. There are no transpiration drops and no odour; the reverse of the plate is crimson. The hyphae are 3·0–7·0 μ in diameter, frequently septate and with dense contents. The aerial hyphae are much branched and interwoven, giving a coarse appearance to the colony.

Macroconidia are produced sparingly on Czapek's agar but abundantly on 2% malt agar after 8 days. They are produced on blunt pionnotes (Fig. 3*a*), and, after 20 days, in chocolate brown flat sporodochia scattered over the surface of the colony. The spores have thick, slightly refractive walls, marked apical and foot cells (Fig. 3*b*), and are mostly 5-septate (Table 1).

Table 1. *Septation and size of macroconidia*

No. of septa	Percentage	Range of size in microns
5	79	29·7–42·9 × 3·3–6·5
4	12	26·4–36·3 × 4·9–6·5
3	6	23·1–39·6 × 4·9–6·5
2	3	33·0–36·3 × 4·9–6·5

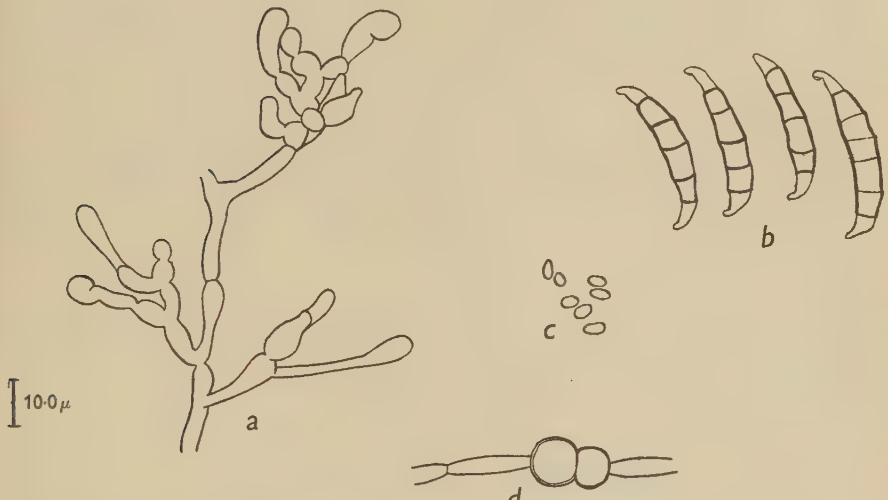

Fig. 3. Morphology of *Fusarium lateritium* Nees; *a*, pionnotes; *b*, macroconidia; *c*, microconidia; *d*, chlamydospores.

Microconidia are produced generally over the aerial mycelium (Fig. 3*c*). Chlamydospores are intercalary and smooth-walled, 13·0–16·0 μ in diameter, but are very rarely produced (Fig. 3*d*). Compact spherical sclerotia, 70–90 μ in diameter, are produced on 2% malt agar after 2 weeks.

The spore characters and appearance of the colony indicate that the isolate is a strain of *F. lateritium* Nees.

INOCULATION EXPERIMENTS

Cuttings of *Dimorphotheca barberiae*, 6–12 cm. high, rooted in sand in a cool greenhouse, were used for pot inoculation experiments. The cuttings were removed from their pots and the roots were washed in sterile water. A number were planted singly in steam-sterilized soil in sterile pots as controls, and an equal number were planted in similar pots to which a 5% inoculum of a sand and semolina culture of *Fusarium lateritium* had been added. The plants were watered in with sterile water and placed in a cool greenhouse.

After 6 days the leaves of the inoculated plants were chlorotic and flaccid, while those of the controls remained deep green and turgid. The roots of the inoculated plants were soft, and the cortex readily sloughed off. Hyphae were present on the surface of the roots, and internally in the cortical cells and stele of the main and lateral roots. The basal parts of the stem were also browned but no hyphae were present. Examination of inoculated plants after 14 days showed hyphal penetration of the vascular tissues of the stem. No penetration of the stem occurred through the cut end of the shoot as the cells in this region were blocked with gum. *F. lateritium* Nees was re-isolated from the roots and stems of the wilted plants.

In the summer of 1950 *Dimorphotheca* plants, which were planted in the bed from which the original wilted material was obtained, showed wilting symptoms similar to those produced experimentally by *Fusarium lateritium* Nees. The pathogen is therefore able to persist in the soil from one season to the next.

A wilt disease has been reported in *Dimorphotheca aurantiaca*, where it is caused by *Verticillium albo-atrum* Reinke & Berth. (Mundkur, 1930), and in *Dimorphotheca annua*, caused by *Fusarium* sp. (Weiss, 1948). The above report shows that it may be produced in *Dimorphotheca barberiae* by *Fusarium lateritium* Nees.

REFERENCES

Cartwright, K. St G. (1929). A satisfactory method of staining fungal mycelium in wood sections. *Ann. Bot., Lond.*, **43**, 412–414.

Mundkur, B. B. (1930). Wilt of African Daisy. *Phytopathology*, **20**, 129.

Weiss, Freeman (1948). *Plant Dis. Reptr.* **32**, 156.

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FACTORS INFLUENCING THE DEVELOPMENT OF RED CORE IN STRAWBERRIES

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(With 1 Text-figure)

Standardized pot-infection techniques were used to study the influence of soil moisture and pH on the development of Red Core of strawberries caused by *Phytophthora fragariae* Hickman. Maximum infection occurs under conditions that promote the liberation of zoospores, namely high soil moisture. This may be provided either by frequent application of water to a freely draining soil or by waterlogging from below. Transport of zoospores by soil water movements is of great importance in promoting infection, particularly where the inoculum is remote from the roots. The influence of soil moisture on the disease varied with soil texture; in general, the lighter the texture the greater the amount of infection.

In single soils adjusted to a range of pH values the amount of infection decreased with rise in pH to the alkaline side. Similar experiments with soils from the field indicated that the relationship between pH and Red Core is less simple for, although little infection occurred in most of the alkaline soils tested, in some the disease was severe.

The results are discussed in relation to the occurrence of Red Core in the field.

Earlier work by one of us (Hickman, 1940) confirmed the opinion long held in Scotland, that Red Core disease of strawberries was due to the parasitism of a species of *Phytophthora*. The fungus was isolated and described as a new species, *P. fragariae* Hickman. The introduction of the disease to fresh areas was shown to be due largely to the establishment of new beds with runners from diseased parent beds, and its subsequent development was correlated with soil moisture conditions, being most vigorous under the wet conditions accompanying impeded drainage. Such conditions, however, are not indispensable for epidemic development of the disease. At Westerham Hill, Kent, where the original work was done, Red Core occurred in certain areas where the drainage was quite free, and in 1946 a survey showed the disease to be making alarming progress in the Tamar valley, Cornwall, where strawberries are grown on slopes so steep as virtually to preclude the possibility of impeded drainage. That the disease is by no means confined to areas where the drainage is impeded has also been the general experience in Scotland (Reid, 1941) and of certain American workers (Anderson, 1935).

In addition to soil moisture some field data from Westerham Hill suggested that the development of Red Core may also be influenced by soil pH. There were few or no diseased plants in areas with soil pH values above 7·0, whereas in adjoining areas with pH values below 7·0, most plants were diseased.

These two factors, soil moisture and soil pH, were selected for further experimental study in relation to the development of Red Core in the hope of gaining a clearer understanding of the etiology of the disease.

METHODS

All experiments were made in a cool greenhouse with the temperature varying generally between 40 and 50° F. The variety of strawberry used was the widely grown, susceptible Huxley, runners being obtained as needed from a certified stock. They were allowed to root for a month, one per pot, in an unsterilized potting compost consisting of loam, peat and sand, in the proportions by volume of 7 : 3 : 2.

In most experiments inoculum of *P. fragariae* was added as mycelium in agar culture. Six disks, each 1·4 cm. in diameter, cut out from the actively growing margin of a 14-day-old culture on bean agar,* were buried, each in a vertical slit just below the surface of the soil, at approximately equal distances around the plant. In other experiments, as conditions demanded, inoculum of agar disks or of infected roots was mixed with the soil before planting, or a suspension of zoospores was poured over the surface of the soil at the rate of 25 c.c. per pot. Zoospore suspensions were prepared by immersing in pond water disks from bean agar cultures. The disks were placed in shallow layers of pond water in glass dishes at the rate of 80 disks to 200 c.c. water. The cultures were incubated at room temperature and the water was replaced by fresh pond water on each of the two succeeding days. By the third day zoospores were present in large numbers. The same isolate, from Cornish material, was used throughout the experiments.

The treatments described below were continued for approximately 3 weeks after addition of inoculum, each treatment having ten replicates. Upon removal from the soil the root systems were washed clean and preserved for examination in formalin-acetic-alcohol. The degree of infection was estimated by measuring the length of the infected portions of main roots, as indicated by the vascular discoloration which gives the disease its name, and expressing this as a percentage of the overall main root length. During autumn and early winter, observations were confined to the main, adventitious roots arising from the stock after planting. Runners planted later had already formed most of their main roots, and all the main roots of such plants were used for assessment of infection. Similar results were obtained with both methods.

The results were examined statistically. Before analysis of variance was performed the percentage values were transformed to angles according to the recommendation of Bliss, discussed by Hayes and Immer (1942). The transformed values so obtained are given in brackets and the values required for significance are based on these figures.

RELATION BETWEEN SOIL MOISTURE AND THE DEVELOPMENT OF RED CORE

Preliminary observations in 1946 showed that heavy infection followed the application of an inoculum consisting of a suspension of zoospores to the surface of soil in pots in which plants were growing under conditions of free drainage. This, together with the field observations already described, suggested that the disease would progress as long as there existed a degree of soil moisture sufficient to ensure the production and dispersal of zoospores, whether the drainage was free or impeded. Such a condition would result from a combination of moderate rainfall with impeded drainage, as at Westerham Hill, or from heavy rainfall on relatively freely draining soil as in the Tamar valley. Experiments were therefore performed to examine the effects on the disease of: (*a*) watering from above under conditions of free drainage; (*b*) waterlogging by standing the pots in saucers of water; and (*c*) a combination of (*a*) and (*b*).

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* Ground seeds of dwarf bean (variety Canadian Wonder) 30 g., agar 20 g., water 1000 c.c. Bean powder stirred into the water and boiled for 5 min.; agar added, dissolved and medium tubed.

Table 1 shows the effect on disease development of varying the frequency of watering under conditions of free drainage. The inoculum of agar disks was buried just below the soil surface, as already described. After addition of inoculum the pots were divided into six series, watered as indicated in the table. The pots were saturated each time they were watered (water running from the drainage hole), and although no attempt was made to apply an equal volume of water to each pot, in practice there was little variation in this respect between one pot and another. The watering treatments were continued for 24 days. The plants were then removed and the degree of infection estimated.

Table 1

Treatment	Average percentage main root length infected
Watered twice daily at 12 hr. intervals	49·2 (43·7)
Watered once daily	20·3 (29·7)
Watered once in 2 days	3·9 (8·1)
Watered once in 4 days	3·2 (6·6)
Watered once in 8 days	0·2 (0·8)
Watered once in 12 days	0·3 (1·0)

(Significant difference: 5%, 7·4; 1%, 9·8)

Very little infection occurred in the plants watered at intervals of 2, 4, 8 and 12 days respectively. More frequent watering however, produced highly significant increases in the amount of infection.

It was apparent from examination of agar disks buried just below the soil surface in pots which were watered at different intervals, from twice daily to once in 4 days, that watering treatments had little effect on sporangial production; sporangia were numerous at each level of watering used. Nevertheless, the more frequent the watering the greater the number of sporangia that germinated. Infection was therefore thought to be due to zoospores formed in the surface soil layer, and carried down to the roots following the application of water to the pots. This conclusion received support from an experiment comparing agar disks with zoospores as inoculum. Treatments as set out in Table 2 were continued for 3 weeks and the plants were then removed for examination.

With agar inoculum little infection occurred at the lower level of watering whereas heavy infection followed zoospore inoculation at the same level of watering. Using agar inoculum, infection was severe at the high level of watering, as it was with zoospore inoculum. The greater infection following zoospore inoculum at this high level of watering may be explained on the grounds that after the introduction of agar inoculum there is an interval of 2 or 3 days, as determined by examination of buried disks, described above, before zoospores are formed and infection can occur. With zoospore inoculum, on the other hand, infection takes place immediately.

Table 2

	Average percentage main root length infected
Agar disk inoculum watered twice daily	58·0 (49·8)
Agar disk inoculum watered once in 2 days	6·4 (9·2)
Zoospore inoculum watered twice daily	69·9 (57·7)
Zoospore inoculum watered once in 2 days	58·6 (50·2)

(Significant difference: 5%, 7·7; 1%, 10·2.)

Having examined the effect of watering freely draining soil contaminated by the fungus, this treatment was compared with waterlogging (the pots standing in saucers of water) and with a combination of watering and waterlogging. The same method of inoculation was used. The results are given in Table 3, the amount of infection being estimated after 3 weeks' treatment.

Table 3

Treatment	Average percentage main root length infected
Watered twice daily	41·6 (40·1)
Watered once daily	28·8 (32·2)
Watered once in 2 days	11·5 (18·1)
Watered once in 8 days	0·0 (0·0)
Watered twice daily, but waterlogged	53·4 (47·0)
Watered once daily, but waterlogged	38·2 (37·0)
Watered once in 2 days, but waterlogged	29·0 (32·2)
Watered once in 8 days, but waterlogged	6·7 (10·2)
Waterlogged, not watered	0·0 (0·0)

(Significant difference: 5%, 7·2; 1%, 9·5.)

Compared with the drained series, the waterlogged, watered series showed a similar reduction in the amount of infection with decrease in frequency of watering, but at each level of watering there was more Red Core in the waterlogged series. The added effect of waterlogging is attributed to the fact that it provides permanent rather than periodic conditions favourable to asexual reproduction. The striking absence of infection in the plants waterlogged but not watered from above, emphasizes the importance of movement of water through the soil on the spread of infection. Examination of agar disks in waterlogged but not watered soil showed that many sporangia are formed under these conditions, and a fair proportion of them germinate. Under the static conditions of the waterlogged pots the remoteness of the inoculum from the roots, placed as it was just below the soil surface, prevented dispersal of zoospores through the soil to the roots. Similarly, there was no infection in the plants watered once in 8 days. The combination of this treatment with waterlogging led to an increase in the amount of infection, which is explained by the transport of zoospores, formed in the wet soil, in the water percolating downwards to the roots following the few occasions on which these pots were watered. In general it might have been expected that in the waterlogged series of soils, infection would have been uniformly high irrespective of the amount of watering from above. The fact that in these series infection increased with increase in frequency of watering, is further evidence of the importance of zoospore transport through the soil in relation to the development of Red Core.

Similar experiments (see Table 4) were made using infected roots as inoculum. These were cut up into small pieces about an inch long, and distributed evenly throughout the soil before planting. During the rooting period the soil was kept moist enough for growth, but care was taken not to encourage Red Core by overwatering. Plants examined before watering treatments began were not infected. An additional series (agar disk inoculum, watered twice daily) was included for comparison.

Table 4

Treatment	Average percentage main root length infected
Watered twice daily	54·6 (48·4)
Watered once daily	41·5 (39·9)
Watered once in 2 days	23·0 (24·3)
Watered once in 8 days	6·6 (5·5)
Watered twice daily, but waterlogged	51·6 (45·4)
Watered once daily, but waterlogged	40·8 (37·4)
Watered once in 2 days, but waterlogged	33·8 (34·6)
Watered once in 8 days, but waterlogged	23·1 (22·9)
Waterlogged, not watered	28·0 (28·7)
Agar disk inoculum, watered twice daily	77·7 (62·9)

(Significant difference: 5%, 10·7; 1%, 14·2.)

Here again a reduction in the development of Red Core follows decrease in the frequency of watering, though it was less marked in the watered-waterlogged series. A further point of contrast with the previous experiment is the occurrence of infection in the waterlogged, not watered series. These differences are attributed to the position of the inoculum. Distributed throughout the soil, and thus in much closer contact with the roots, the chances of zoospore infection succeeding, irrespective of dispersal by water movement through the soil, were much greater.

Another experiment was made to examine the effect of degree of soil moisture on the development of Red Core. A series of glazed jars were filled with compost containing distributed root inoculum, at a moisture content of 40% of its water-holding capacity (w.h.c.) which had previously been determined (Piper, 1942). This moisture level was high enough to allow growth of the runners planted in the soil but not to permit infection, as was proved by its absence in the series kept at 40% w.h.c. throughout the experiment. The pots were grouped into four series. In one the soil moisture level was maintained at 40% w.h.c.; in the others it was raised, by addition of further water, to 50, 70 and 90% w.h.c. respectively. The pots were weighed on alternate days and the moisture levels kept constant by very small additions of water. After 24 days the plants were removed for disease assessment. The figures are given in Table 5. The results again emphasize the dependence of the fungus on a high soil moisture level.

Table 5

Percentage water-holding capacity	Average percentage main root length infected
40	0·0 (0·0)
50	0·8 (1·7)
70	2·4 (4·8)
90	25·1 (27·9)

(Significant difference: 5%, 5·5; 1%, 7·4.)

The experiments so far described were all made in soil of one type, but others were carried out to test the effect of frequency of watering in soils of different texture. In the first experiment of this nature, texture was modified by adding increasing quantities by volume of sand to the sieved loam used as the basis of the greenhouse potting compost. Five different soil types were thus made up, ranging from pure loam to a mixture of one part loam and four parts sand. Agar disk inoculum was buried just below the soil surface and for each soil type there were three levels of watering, twice daily, once daily and once in 4 days. The plants were removed 3 weeks after watering treatments began. The results are given in Table 6.

Table 6

Loam/sand proportion	Watering	Average percentage main root length infected
Pure loam	Twice daily	34·1 (34·6)
4 loam, 1 sand	Twice daily	53·5 (47·1)
3 loam, 2 sand	Twice daily	60·9 (51·8)
2 loam, 3 sand	Twice daily	67·3 (55·7)
1 loam, 4 sand	Twice daily	57·2 (49·2)
Pure loam	Once daily	8·2 (13·7)
4 loam, 1 sand	Once daily	18·7 (21·3)
3 loam, 2 sand	Once daily	35·0 (35·8)
2 loam, 3 sand	Once daily	43·7 (41·2)
1 loam, 4 sand	Once daily	41·0 (39·6)
Pure loam	Once in 4 days	0·2 (0·8)
4 loam, 1 sand	Once in 4 days	1·8 (3·5)
3 loam, 2 sand	Once in 4 days	1·5 (4·2)
2 loam, 3 sand	Once in 4 days	4·3 (8·8)
1 loam, 4 sand	Once in 4 days	4·6 (10·5)

(Significant difference: 5%, 6·1; 1%, 8·1.)

In a second experiment sand and china clay were mixed in different proportions by weight, and sieved loam was added to each mixture in the proportion of one to four by volume. Thus in each series the loam content was constant, variation in texture being provided by the variation in the sand/clay proportion. It was intended to have three levels of watering as before, but some of the pots of the high clay series became completely waterlogged or caked and cracked during the preliminary rooting period and so were discarded, leaving only enough pots for twice and once daily watering. The experiment was continued for 3 weeks. The level of infection was lower in this experiment, as shown by the results in Table 7.

Table 7

Sand/clay proportion	Watering	Average percentage main root length infected
5 sand, 5 clay	Twice daily	0·9 (2·6)
7 sand, 3 clay	Twice daily	2·3 (5·4)
9 sand, 1 clay	Twice daily	15·5 (19·9)
Pure sand	Twice daily	25·9 (29·9)
5 sand, 5 clay	Once daily	0·0 (0·0)
7 sand, 3 clay	Once daily	6·4 (8·2)
9 sand, 1 clay	Once daily	5·1 (10·4)
Pure sand	Once daily	11·3 (17·2)
7 sand, 3 clay	Once in 4 days	0·0 (0·0)
9 sand, 1 clay	Once in 4 days	0·5 (4·6)
Pure sand	Once in 4 days	3·5 (8·3)

(Significant difference: 5%, 7·6; 1%, 10·0.)

The results of these two experiments again illustrate that increase in frequency of watering is accompanied by increase in the amount of infection. Superimposed on this is an effect due to soil texture: in general, the lighter the texture of the soil the greater the amount of infection.

Relation between soil pH and the development of Red Core

A characteristic feature of the distribution of Red Core, as shown by field surveys, is that the disease is confined to acid soils and there has thus been little opportunity in the field to compare its progress on acid and alkaline soils, side by side. Hickman (1940) reported two cases at Westerham Hill where the evidence suggested that the disease was checked by soil alkalinity. Fig. 1 illustrates the distribution of Red Core in one of these strawberry beds, and this distribution was apparently related to soil pH. The bed had been established with runners from a diseased parent bed and in the summer of 1939, 2 years after planting, the disease was present in a wide strip stretching diagonally across the bed, as well as in a small corner patch. There was no indication of any major differences in the water relations of the soil corresponding to the striking delimitation of the diseased and healthy areas. However, determination of the pH values of soil samples from the diseased areas gave an average value of 6·1, at the junction of diseased with healthy areas, 7·0, and in the healthy areas, 7·9. A similar relationship between soil pH and the distribution of Red Core was also observed in a second bed not far away.

This problem was approached by examining the relation between pH and the biology of the fungus in the laboratory, and by comparing the development of Red Core in soils of different pH value.

Table 8 gives the results of experiments made to investigate the influence of pH on the growth of *P. fragariae* on oatmeal agar. In the first experiment the pH of the agar was adjusted by means of phosphate buffer mixtures, and pH measurements were made after the melted agar had been diluted 1 in 10 with distilled water. In the second experiment pH values were made directly on melted, undiluted agar, cooled to 40° C. in a water-bath. Three isolates, from Scotland, Kent and Cornwall, were used, but as all three showed the same response only the figures for the Cornwall isolate are given. The measurements, average of duplicates, were made after 8 days' incubation at 17° C., and are given in millimetres.

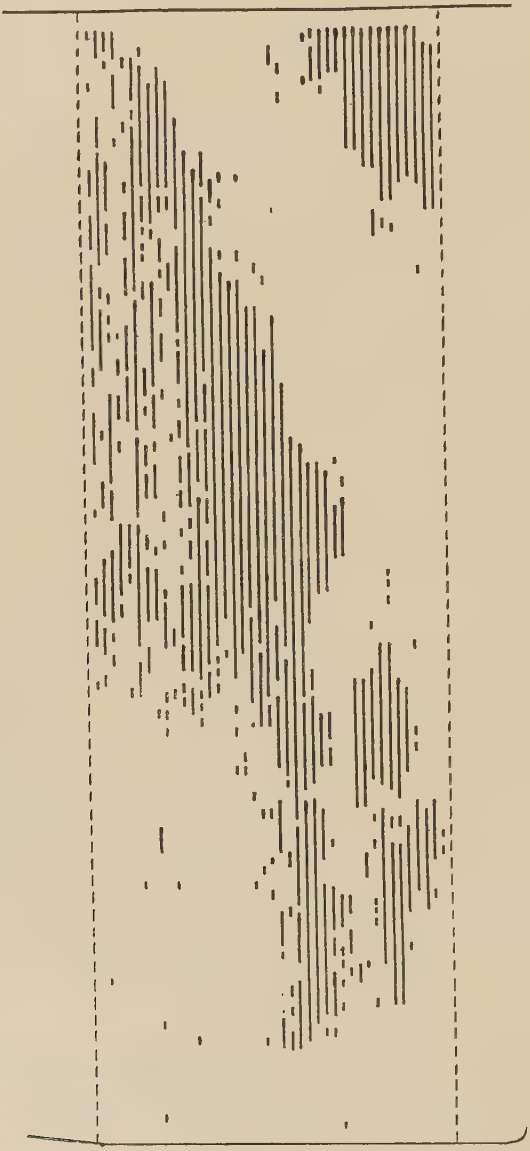

Fig. 1. Showing the distribution of Red Core (indicated by black lines) in a bed of strawberries at Westerham Hill, Kent, 2 years after its establishment in 1937 with runners from a diseased parent stock. For explanation see text.

Table 8

Exp. 1		Exp. 2	
pH	Colony diameter	pH	Colony diameter
4·46	—	5·18	54·0
4·68	Trace	5·38	55·0
5·08	51·5	5·68	55·0
5·52	65·0	6·02	58·0
6·06	62·5	6·30	64·0
6·48	65·5	6·70	62·0
7·00	62·0	7·35	29·0
7·50	35·0	9·40	—
7·86	16·0		
8·62	Trace		

Below pH 5·0 and above pH 7·0 growth falls off very rapidly. Somewhat similar results were obtained in America by Bain and Demaree (1945), though their isolates were more tolerant of acidity, and grew over a range from 4·0 to 7·6, most vigorously and rapidly between 6·0 and 7·2.

Having regard to the importance of zoospores as inoculum, attempts were next made to investigate the influence of soil pH on the production and germination of sporangia of *P. fragariae*. Under natural conditions sporangia are formed on infected roots and release their zoospores into the soil solution. It was undesirable to use infected roots as experimental material because of the impossibility of standardizing the method and of obtaining supplies as required. Disks of an agar culture were therefore used. They were placed in a shallow layer of a water extract of the soil under test and counts were made of the sporangia formed, and of those that had germinated over a period of from 1 to 3 days, when asexual reproduction had reached a maximum. The technique was not satisfactory and was subject to a high degree of error. The results are therefore not given in detail. Hundreds of sporangia were formed in some extracts, and it was impossible always to make accurate counts, particularly of germinated sporangia, which, on their collapse, become very inconspicuous. Nevertheless, there was an indication, both in extracts of soils artificially adjusted to varying pH levels by addition of calcium hydroxide, and with soils of naturally differing pH, that values above 7·0 were unfavourable for asexual reproduction. An extract of a natural soil, of pH 8·0, provided a marked exception, for in extracts of this soil many sporangia formed and germinated.

What is considered to be more reliable evidence of the influence of soil pH on the development of Red Core was obtained by examining the progress of the disease, using agar disks or infected root tissue as inoculum, in soils artificially adjusted to different pH values, and in soils of different pH value, collected from the field.

Two sandy, naturally acid soils from the Birmingham area, of pH 4·7 and 5·5 respectively, were used as the basis of the adjusted pH series of soils. Pilot experiments, in which small quantities of the two soils were shaken with varying quantities of calcium hydroxide solution, provided data on the amounts of pure calcium hydroxide needed to raise the pH of bulk samples to the desired levels. The soils showing natural differences of pH were collected from Worcestershire, and from the Wisbech, King's Lynn and Cheddar areas.

The effect of pH as observed in adjusted soils and using agar disks as inoculum, is shown in Table 9. The soils were adjusted to their pH values some months beforehand. All watering, both in the rooting and infection period, was with distilled water. After addition of inoculum the pots were watered once daily. The pH values of the soils were measured at the beginning and end of the experiment by means of a glass electrode.

Table 9

Initial pH	Final pH	Average percentage main root length infected
	Soil A	
4·7	4·8	8·8 (13·8)
6·3	6·2	24·1 (28·4)
6·8	6·8	11·8 (16·1)
7·7	7·5	6·8 (12·0)
	Soil B	
5·4	5·3	28·7 (31·1)
6·7	6·7	11·0 (17·7)
8·2	7·9	4·2 (6·3)
8·7	8·4	1·9 (3·5)

(Significant difference: 5%, 10·3; 1%, 13·6.)

In both soils there was a reduction in disease development with rise in pH to the alkaline side.

The experiment was repeated using infected root tissue as inoculum. In this and subsequent experiments the pots were watered twice daily with tap water, for experiments had by now shown that tap water does not cause any change in pH compared with distilled water. The results are given in Table 10.

Table 10

Initial pH	Final pH	Average percentage main root length infected
	Soil A	
4·7	5·1	43·6 (39·5)
6·3	6·4	60·1 (51·4)
6·8	7·0	45·8 (39·2)
7·7	7·8	27·3 (30·0)
	Soil B	
5·7	5·7	37·7 (37·4)
7·0	7·2	33·6 (34·4)
8·4	8·5	28·0 (31·5)
8·7	8·7	27·7 (27·9)

(Significant difference: 5%, 13·5; 1%, 17·8.)

The general level of infection in this experiment was distinctly higher and only in the A series of soils was there a significant reduction in infection with rise in pH to the alkaline side.

Using agar disk inoculum, similar tests were made in soils showing natural differences of pH and collected from Worcestershire (Wo.), Wisbech (Wi.), King's Lynn (K.L.) and Cheddar (Ch.). The results of three such experiments are summarized in Table 11.

Table 11

Soil	Initial pH	Final pH	Average percentage main root length infected
Wo. 1	5·2	5·2	13·2 (15·8)
Wo. 2	5·6	5·8	47·1 (43·1)
Wo. 3	6·6	6·8	41·8 (40·0)
Wo. 4	6·7	6·6	20·8 (25·1)
Wo. 5	7·7	7·9	9·0 (12·4)
Wo. 6	8·0	8·0	9·7 (11·7)
Wi. 12	6·8	7·1	26·6 (27·9)
Wi. 1	7·8	7·8	46·2 (43·4)
(Significant difference: 5%, 12·2; 1%, 16·2.)			
Wi. 8	6·4	6·5	31·8 (33·7)
Wi. ?	6·5	6·5	11·2 (17·6)
Wi. 9	6·8	6·8	12·2 (17·7)
Wi. 1	7·8	7·9	34·5 (35·0)
Wi. 6	7·8	7·9	1·1 (3·6)
Wi. 10	8·0	8·0	2·2 (5·1)
Wi. 5	8·0	8·2	0·1 (0·6)
Wi. 2	8·0	8·2	14·7 (19·2)
K.L. 2	8·1	8·1	1·5 (3·0)
(Significant difference: 5%, 9·2; 1%, 12·2.)			
Ch. 1	7·8	7·9	41·3
Ch. 2	7·8	7·9	29·5
Ch. 3	7·9	8·0	9·1

It is quite clear from these experiments with soils from the field that the relationship between soil pH and Red Core is not as straightforward as the experiments with adjusted soils suggest, for in three of the twelve alkaline soils, Wi. 1, Ch. 1 and Ch. 2, there was heavy infection. Moreover, though in general the acid soils proved more favourable for the development of the disease, there was marked variation in soils of similar pH values.

Discussion

It is a reasonable assumption that with interchange of runners between one strawberry-growing district and another, inoculum of *P. fragariae* has been distributed widely over the country. Nevertheless, the disease does not occur uniformly throughout every strawberry-growing area: nor are the conditions the same in each of the areas where it does occur. It was clear from earlier field observations that the distribution of Red Core is related to soil moisture, and, to a less extent, to soil pH. Experimental investigation has confirmed these observations and extended our knowledge of their interrelationships with the disease. It has been shown that maximum infection occurs under conditions that promote the liberation of zoospores (high soil moisture), and their transport through the soil to the roots. High soil moisture may follow waterlogging, a condition equivalent to impeded drainage, which was early observed in the field to be associated with outbreaks of Red Core. But this in itself does not necessarily lead to heavy infection, particularly if the inoculum is not in the immediate vicinity of the roots. Transport of inoculum by means of water movement through the soil is of great importance, and experiments have shown the significance of such movement in increasing the level of infection. In fact, provided water is applied often enough, simulating conditions in a region of heavy rainfall, the disease will develop rapidly in a soil with completely free drainage.

The development of Red Core under such widely varying conditions as are found, for example, in the Tamar valley and in Essex is therefore understandable. Table 12 gives the average annual rainfall, and the average for the period October to March (when *P. fragariae* is actively parasitic) over the 10-year period 1939–48 for Red Core areas in England.

Table 12. *Rainfall in inches*

Locality	Average for the year	Average for October–March
Cornwall (Tamar valley)	45·20	26·40
Kent (Westerham Hill)	32·33	18·41
East Sussex	30·16	17·08
Hants (Botley)	29·95	17·41
Essex	21·63	11·68

The Tamar valley is outstanding in its very high rainfall and here, on the steep slopes that are such a feature of the area, frequent rainfall provides the necessary conditions for the development of the fungus and transport of zoospores. In the other areas the necessary conditions are provided by a combination of low to moderate rainfall with impeded drainage, a soil condition which field surveys in these districts have shown to be associated with outbreaks of Red Core. A high level of soil moisture is built up in a false water-table by the retention of the rain water over the impermeable subsoil. In the absence of impeded drainage the disease does not occur. There are exceptions of course, as mentioned in a previous paper (Hickman, 1940, p. 111), but work on infection by zoospores now described, provides support for the suggestion made then that the disease can spread from a badly drained area to a freely draining area as a result of water movement carrying zoospores from the former to the latter.

In the Clyde valley there is also high rainfall, averaging 36 in. over the same 10-year period, and, leaving aside badly drained soils, Reid (1949) has drawn attention to the relation between the intensity of Red Core and the number of days on which rain actually falls. He has observed that 'in the most severely affected districts in the west of Scotland, during the 6 months October to March (182 days) rain may fall on 90–130 days. At the lower figure damage is not usually marked, but in years when the higher figure is approached, loss from Red Core is likely to be heavy wherever infection is present.'

The results of experiments with soils of different texture lend support to the view that heavy infection occurs rapidly in freely drained soils under conditions of high rainfall and that, within certain limits, such a combination of factors provides the most favourable conditions for the progress of the disease. No precise explanation of the influence of soil texture can be given. Aeration may play an important part in the biology of *P. fragariae* but, as Garrett (1944) has pointed out, it does not necessarily follow that because a particular disease is favoured in light-textured soils, this is due to improved aeration, for other differences, such as pH and nutritional status, may be bound up with differences in soil texture. Against this is the fact that the effect on Red Core was observed when, in the second texture experiment described, such sources of variation were excluded by using an equal amount of loam in each soil and creating texture differences by the incorporation of different quantities of the relatively inert materials, sand and clay.

Turning to the influence of pH, experiments with single soils, adjusted to cover a range of pH values, indicated a decrease in the amount of infection with rise in pH to the alkaline side. This effect was not uniformly reflected, however, in the results of infection experiments in a range of soils collected from the field. It is true that little infection occurred in the majority of the alkaline soils, but in some of them Red Core was severe; and, further, there was relatively little infection in a few of the acid soils examined. These field soils, collected over a very wide area, naturally differed in other respects than pH value, and the explanation of the variable results is no doubt to be sought in some other factor or factors of soil environment. Having regard to the influence of soil texture on Red Core, mechanical analyses were made of some of the field soils but there was no correlation between texture, as deduced from the relative proportions of sand, silt and clay, respectively, and degree of infection.

That alkalinity should check the disease is in direct contrast with experience in Scotland (private communication from R. D. Reid), where it was found that heavy and continuous liming had no effect whatever on the disease. The problem there, however, was different in that attempts were made to check the development of the fungus by liming after it had become firmly established in acid soil, whereas Hickman's (1940) original observations and our own experiments were concerned with the development of the fungus after its introduction into an alkaline soil. Whatever the explanation there is no doubt that following the introduction of inoculum, some alkaline soils limit the progress of the disease, and others favour it.

Red Core has not been recorded in the large strawberry-growing area around Wisbech and King's Lynn. Here alkaline soils predominate and, even though alkalinity may not always be a limiting factor, the absence of the disease can be explained in terms of the low rainfall and excellent drainage. For the 10-year period 1939–48 the average annual rainfall was 21·9 in. and for the period October to March, 12·49 in. It is probably true also of the Cheddar district that the soils are in the main alkaline, the three samples examined being collected from representative areas of this small strawberry growing district. In view of the results of pot experiments the absence of Red Core here can hardly be explained on the basis of alkalinity. With rainfall figures somewhat similar to those for Kent (an average of 33·72 in. for the period 1939–48 and 19·95 in. for October to March) the explanation is probably to be sought in the drainage capacity of these soils but this is a question on which we have had no opportunity of obtaining direct evidence.

This work was made possible by a grant to the senior author from the Agricultural Research Council, to whom grateful acknowledgement is made. Our thanks are extended to all those who have helped us in this investigation.

REFERENCES

Anderson, H. W. (1935). Black stele root rot of strawberry (Abstr.). *Phytopathology*, **25**, 5.

Bain, H. F. & Demaree, J. B. (1945). Red stele root disease of the strawberry caused by *Phytophthora fragariae*. *J. agric. Res.* **70**, 11–30.

Garrett, S. D. (1944). *Root disease fungi*. Waltham, Mass.: Chronica Botanica Co.

Hayes, H. K. & Immer, F. R. (1942). *Methods of Plant Breeding*. New York: McGraw Hill.

Hickman, C. J. (1940). The Red Core root disease of the strawberry caused by *Phytophthora fragariae*, n.sp. *J. Pomol.* **18**, 89–118.

Piper, C. S. (1942). *Soil and Plant Analysis*. University of Adelaide.

Reid, R. D. (1941). Red Core disease of the strawberry. *Scot. J. Agric.* **23**, 264–272.

Reid, R. D. (1949). Breeding strawberries for disease resistance. *J. Minist. Agric. Lond.*, **55**, 476–482.

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TRIPHRAGMIUM PONDEROSUM (SYD. & BUTL.) N.COMB.

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The characters distinguishing *Hapalophragmium* Syd. from *Triphragmium* Link, and the different species of *Hapalophragmium* are analysed, and the view is expressed that there is no reason to separate *Hapalophragmium* from *Triphragmium*. The new genus *Hapalophragmiopsis* Thirum. is considered unnecessary. A new combination *Triphragmium ponderosum* (Syd. & Butl.) Venkatarayan is suggested.

The genus *Triphragmium* was founded by Link in 1825 (not 1824, vide Milesi & Traverso, 1904), the type species being *T. ulmariae* causing large deformities on the stems and leaf veins of *Filipendula ulmaria* in Europe, North Asia, and North America. A new genus, *Hapalophragmium*, was described by H. and P. Sydow (1901) on *Derris uliginosa* in Tanga (the then German East Africa), and in the island of Nossi-Be near Madagascar, the type species being *H. derridis* Syd. n.sp. This fungus has not been recorded in India, but Petch (1912) records it from three localities in Ceylon on the same host. In discussing the relationships of this new genus the Sydows state that it resembles *Triphragmium*, *Sphaerophragmium* and *Anthomyces*, the teliospores appearing like a reversed *Triphragmium* spore. The chief difference between *Triphragmium* and *Hapalophragmium* is in the position of the stalk of the teliospore. In *Triphragmium* the three cells are so arranged that a single cell stands on the stalk and the other two side by side at the end of this cell. In *Hapalophragmium* two cells stand on a common stalk, and the third stands on these cells. Dietel (1928) agrees with the Sydows in separating *Hapalophragmium* from *Triphragmium*. The urediospores of *Triphragmium* do not possess germ pores, while those of *Hapalophragmium* possess two pores according to the Sydows and several according to Dietel.

The Sydows (1904) transferred *Triphragmium setulosum* Pat. to *Hapalophragmium* on the basis of the stalk of the teliospores, and Dietel (1928) follows them. *Triphragmium anomalum* Tranzsch. on *Filipendula palmata* has four-celled teliospores and is still retained in *Triphragmium* by Dietel (1928). *Hapalophragmium pulchrum* (Racib.) Syd. was first described as *Triphragmium pulchrum* Racib. on *Derris elliptica* in Java. Milesi and Traverso (1904) describe the teliospores of this fungus as pedicellate on the basal cell. This species was made the type of a new genus *Triactella* Syd. under the binomial *T. pulchra* (Racib.) Syd. Dietel (1928) describes the teliospores of *T. pulchra* as pedicellate on the basal cell, and he is not sure if it should be separated from *Triphragmium* because of its occurrence on a leguminous plant. Sydow and Petrak (1931) have withdrawn this genus, and named the species *Hapalophragmium pulchrum* (Racib.) Syd. They state that the stalk of the teliospores is between two basal cells and that the figure of Milesi and Traverso is entirely false. Apparently the position of the stalk of the teliospores may not be a reliable criterion for the separation of the genera.

Sydow and Petrak (1931) state that the teliospores of *H. pulchrum* are warted, particularly at the ends and basal parts of the cells, while the sides are mostly smooth, though spores with warts on the sides may be found. The species of *Hapalophragmium* differ, moreover, in the possession of paraphysate sori and warts near the germ pores of the teliospores. Paraphyses have been noted in *H. setulosum*, *H. pulchrum*, *H. anamalaiensis* Ramak. T. S. & K., *H. mysorense* Thirum. and *H. millettiae* Syd. (Sydow, 1937). The teliospores have warts near the germ pores in *H. setulosum*, *H. pulchrum* and *H. mysorense*, while those of *H. ponderosum* Syd. & Butl. are finely warted all over, and those of *H. acaciae* Baccarini (Saccardo & Trotter, 1925) and *H. tandonii* Mitter are densely and thickly warted all over. The teliospores are smooth in *H. derridis*, *H. anamalaiensis* and *H. millettiae*. Another character which is said to distinguish *H. anamalaiensis* (Ramakrishnan & Ramakrishnan, 1948) from the type species is that its sori are hypophyllous and not amphigenous. According to the Sydows (1901), the sori of *H. derridis* are chiefly hypophyllous, only rarely occurring on the upper surface. The characters used in distinguishing *Hapalophragmium* from *Triphragmium*, and between the different species of *Hapalophragmium* do not seem to be dependable, and it would be safe to follow Clements and Shear (1931) in considering *Hapalophragmium* and *Triactella* as synonyms of *Triphragmium*.

Sydow, Sydow and Butler (1912) described *Hapalophragmium ponderosum* on branches of *Acacia leucophloea* from Poona as a new species. This fungus forms numerous big telial galls on the main stems and branches of the host, and is quite common in Bangalore and in the Salem and Coimbatore districts of Madras State, and is reported also from the Nellore and Chittoor districts of Madras. Urediospores are lacking, and hence the presence or absence of pores could not have been the determining factor in its identification. It has delicately warted teliospores pedicellate between the two basal cells. Thirumalachar (1941) has recorded subepidermal pycnia for this fungus. *Hapalophragmium tandonii* (Sydow, Mitter & Tandon, 1937) is a totally different species on the same host, forming minute sori exclusively on the leaves and tender petioles, the teliospores being like those of *H. ponderosum* but regular, with coarse warts all over, and a uniformly thick epispore.

Thirumalachar (1950) has described a new species, *H. mysorense* on *Derris benthamii* Thw. from Mysore which possesses subcuticular pycnia and subepidermal uredinoid aecia. *Triphragmium ulmariae*, the type of the genus *Triphragmium*, also possesses subepidermal aecia. Thirumalachar has pointed out that the species of *Hapalophragmium* on *Derris* are closely related, and yet because the species on *Derris benthamii* differs from *Hapalophragmium setulosum* and *H. pulchrum* in the size of the uredio- and teliospores (but only very slightly from those of *H. derridis*, the type) he has created a new species. He attributes the pycnial and aecial characters of *H. mysorense* to the entire genus *Hapalophragmium* without examining the type of the genus or the type specimen of any other species of *Hapalophragmium*.

On this basis, and because *H. ponderosum* has subepidermal pycnia, Thirumalachar (1950) creates a new genus *Hapalophragmiopsis* for it without verifying the type specimen of the species described by Sydow and Butler. The ending *-opsis*, though often used in generic names of fungi, is contrary to Recommendations X (*f*) and XI (*b*) according to which the suffix *-oides* or *-opsis* may be used for the name of a subgenus or section which resembles another genus. The subepidermal or subcuticular character of pycnia is a broad concept used for distinguishing subfamilies and tribes by Dietel (1928) and is not necessarily a generic character. The spread of the mycelium in the host tissues is conditioned, among other things, by the mechanical elements present and the chemical reaction of the cells, which are host characters rather than characters of the fungus. Thirumalachar (1950) expresses the opinion that since the other gall-forming rust on *Acacia* sp. in Somaliland, *Hapalophragmium acaciae*, is reported to resemble *H. ponderosum* closely (but not in the nature of the wall of the teliospores) it may prove to be a species of *Hapalophragmiopsis* when its pycnial stage is discovered. But if *H. derridis* itself should prove to have subepidermal pycnia, the basis for the erection of the new genus *Hapalophragmiopsis* will disappear. Hence the ascription of characters to the genus *Hapalophragmium* by Thirumalachar (1950) and his founding of the new genus *Hapalophragmiopsis* are both hypothetical. It is proposed that *Hapalophragmium ponderosum* Syd. & Butl. be transferred as **Triphragmium ponderosum** (Syd. & Butl.) Venkatarayan, n.comb.

Synonyms

Hapalophragmium ponderosum Syd. & Butl. *Ann. Mycol.* **10**, 265 (1912).
Hapalophragmiopsis ponderosum (Syd. & Butl.) Thirum. *Mycologia*, **42**; 227 (1950).

REFERENCES

Clements, F. E. & Shear, C. L. (1931). *The Genera of Fungi*, p. 338. New York.

Dietel, P. (1928). Uredinales, in Engler u. Prantl: *Die natürlichen Pflanzenfamilien*. 2. Aufl. **6**, pp. 64 and 69.

Milesi, M. & Traverso, G. B. (1904). Saggio di una monografia del genre *Triphragmium*. *Ann. mycol., Berl.*, **2**, 143–156.

Petch, T. (1912). Ustilagineae and Uredineae of Ceylon. *Ann. R. bot. Gdns. Peradeniya*, **5**, 237.

Ramakrishnan, T. S. & Ramakrishnan, K. (1948). Additions to fungi of Madras IV. (21) *Hapalophragmium anamalaiensis* Ramakrishnan, T. S. & K. sp.nov. *Proc. Indian Acad. Sci.* B, **27**, 41–42.

Saccardo, P. A. & Trotter, A. (1925). *Sylloge fungorum*, **23**, 788.

Sydow, H. (1937). Novae fungorum species. XXV. *Hapalophragmium Millettiae* Syd. nov.spec. *Ann. mycol. Berl.*, **35**, 249–250.

Sydow, H. & Sydow, P. (1901). *Hapalophragmium*, ein neues Genus der Uredineen. *Hedwigia*, **40** (Beibl. 3), 62–65.

Sydow, H. & Sydow, P. (1904). Neue und kritische Uredineen. *Hapalophragmium setulosum* (Pat.) Syd. *Ann. mycol., Berl.*, **2**, 350.

Sydow, H., Sydow, P. & Butler, E. J. (1912). Fungi Indiae orientalis. Pars. IV. *Ann. mycol., Berl.*, **10**, 265.

Sydow, H., Mitter, J. H. & Tandon, R. N. (1937). Fungi Indici. III. *Hapalophragmium tandonii* Mitter n.sp. *Ann. mycol., Berl.*, **35**, 225–226.

Sydow, H. & Petrak, F. (1931). Micromycetes philippinenses. Series secunda. *Ann. mycol., Berl.*, **29**, 160.

Thirumalachar, M. J. (1941). *Hapalophragmium ponderosum* Syd. on *Acacia leucophloea* Willd. *J. Indian bot. Soc.* **20**, 293–298.

Thirumalachar, M. J. (1950). Some noteworthy Rusts. III. *Mycologia*, **42**, 224–232.

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REVIEWS

The British Smut Fungi (*Ustilaginales*). By G. C. AINSWORTH and KATHLEEN SAMPSON. (Kew, Surrey: The Commonwealth Mycological Institute, 1950.) 137 pp., 21 text-figures and 2 plates. Price 20*s*. net, or $3.

There has been no serious monograph on the British smut fungi since that by Plowright in 1889. There have been lists of smut fungi, the most recent and extensive being that by Miss Sampson in 1940, as one of a series of exhaustive surveys planned by the British Mycological Society. But this serious gap has at last been filled by the above work, one which should satisfy both teaching staffs and systematic mycologists not only in this country but further afield. The principal portion of this excellent monograph is a detailed description of all recorded species of smuts in the British Isles which now number 74, as against the 49 true smuts given in Plowright's work. The first 44 pages deal with economic aspects of smuts, their biology and culture, cytology and genetics, classification and technique. The last heading is possibly misleading since here control measures are discussed along with collection and treatment of herbarium material, examination of spores, growth and compatability studies, methods of infecting the host, stains and fixatives. All this material will be found of great use not only to specialist workers but to the advisory officers in plant pathology, who have little time to search original research papers, since the literature even on this subject is voluminous.

The authors are perhaps over cautious in their statement that in Great Britain some growers make a practice of applying organo-mercurial dusts to cereal seeds: it could be safely stated that the majority do so and in Scotland about 75 % of seed oats are so treated. The Crop Protection Products Approval Scheme is referred to but it is a voluntary one and does not test the products approved. Approval is granted on guarantees that the products conform to certain chemical and physical standards, and on evidence of field efficiency. In this respect the Great Britain scheme differs from otherwise fairly similar schemes in Germany, Holland, U.S.A., etc., where often testing is a pre-requisite to approval and where the schemes are often compulsory. With regard to the control of onion smut, the authors do not mention the simpler procedure of raising seedlings in steam- or formalin-sterilized soil in frames or glasshouses and transplanting to the field when 4 in. or more in height. Incidentally, this smut is no longer notifiable in England and Wales—it never was notifiable in Scotland—but its distribution is checked under the requirements of the 'Sale of Diseased Plants Orders' of England and of Scotland.

The descriptions of the individual smuts are very full and well supported by good line-drawings, and there is a wealth of information gathered from literature not always very accessible. It is not a surprise to find that the authors have adopted the suggestion of Cunningham to combine the Loose Smuts of wheat and barley under *Ustilago nuda* and that of Fischer to combine the Covered Smuts of barley and oats under *U. hordei*. It is hoped that this will be acceptable to the committee responsible for the List of Common British Plant Diseases. It is open to doubt whether the term 'widespread' has always been used correctly in these descriptions. Normally the term indicates reasonable intensity, as well as extent, of distribution but in some cases this interpretation would not hold. For example, *U. tragopogonis-pratensis* occurs in only a few localities in Scotland and even then not abundantly: although the host is not so common in Scotland as in England, the smut is not equally distributed with it. On the other hand, Bunt can be said to be very rare in Scotland. It is interesting to note how certain smuts are rare in one or other part of the British Isles and often these have been collected only once. Is this a reflexion on the dearth of collectors, especially of those clerics with a bent for natural history and with ample time and means? The professional plant pathologist rarely has time to devote to plants other than economic crops, and the band of mycologists who may be somewhat freer to do so is, alas, somewhat small to cover this country adequately. Alternatively, one may wonder how many small, provincial herbaria remain untapped: distribution of certain smuts, and other fungi, might be shown to be wider than at present indicated and so might influence the approach to the study of the factors influencing distribution.

U. bullata is only listed as in England but there is one collection, under *U. bromivora*, from Aberdeenshire in the herbarium of the Department of Agriculture for Scotland.

Typographical errors are negligible. Authors and publishers are to be congratulated on this excellent book, the possession of which will make the work of mycologists and plant pathologists considerably easier. C. E. FOISTER

The Actinomycetes: their Nature, Occurrence, Activities and Importance. By SELMAN A. WAKSMAN. (Waltham, Mass.: The Chronica Botanica Co.; London, W.C. 2: Wm. Dawson and Sons Ltd., 1950.) 230 pp., 39 text-figures. Price $5.00.

The actinomycetes are organisms of great natural significance. They occur in most soils in great numbers and in the alkaline soils of arid regions they may become numerically the dominant element of the microflora. Those degradative changes in soil which turn plant and animal remains once more into substances suitable for assimilation by green plants are the result of metabolic activity of many kinds of micro-organism, but among these the actinomycetes take a place of primary importance.

It may appear strange, therefore, that this group should have received, until recently, so little attention from microbiologists and that Prof. Waksman's book should be the first to give a general treatment of their structure and biology. One is tempted to think that this neglect may have been due in part to the common view that the actinomycetes occupy a systematic position between fungi and bacteria, so that both mycologists and bacteriologists could consider them to be outside their legitimate sphere of interest. Prof. Waksman briefly discusses their systematic position and appears to incline to the view that they do show relationships to both fungi and bacteria. Nevertheless, I feel that the evidence from structure and life history presented in this book weighs heavily in favour of their close relationship to bacteria, especially to such genera as *Mycobacterium* and *Corynebacterium*, and that any resemblance to fungi is superficial only and of little if any phylogenetic significance.

Be that as it may, there is no doubt that the recent emergence of the actinomycetes from semi-obscurity is largely due to the discovery of their remarkable capacity for producing antibiotics. Not only do a high proportion of isolates produce antibiotics but they have produced several of potential importance in medicine (e.g. streptomycin, aureomycin, chloromycetin and terramycin), whereas the fungi have provided only one and the bacteria none. No one has been more prominent in this field of research than Prof. Waksman, but it is characteristic of the balanced nature of his book that he does not overstress this facet of their biology but also deals effectively with their metabolic activities in soil and their role as pathogens of animals and plants as well as with their morphology and taxonomy.

The classification adopted in this book is that which appears in the most recent (1948) edition of Bergey's *Manual of Determinative Bacteriology* and which was derived from a scheme proposed by Waksman and Henrici in 1943. According to this system the Order Actinomycetales contains five genera—*Mycobacterium*, *Actinomyces*, *Nocardia*, *Streptomyces* and *Micromonospora*—of which the last four only are what one usually considers to be actinomycetes. It might be thought that Prof. Waksman does less than justice to the views of recent Italian and French workers but his scheme of classification does appear to be workable and solidly founded. Those seeking to identify species in this rather difficult group will be greatly helped by this book used in conjunction with Bergey's *Manual*. Mycologists may be somewhat intolerant of the importance attributed to biochemical characteristics of species.

This book is well bound and printed in a readable type on good paper. Misprints and incorrect cross-references are almost completely absent. I have said earlier that this treatment of the actinomycetes fills a gap in the literature of microbiology; it should also be said that it fills the gap with distinction. P. W. BRIAN

Mycotrophy in Plants. By A. P. Kelley. (Waltham, Mass.: The Chronica Botanica Co.; London, W.C. 2: Wm. Dawson and Sons Ltd., 1950.) xiv+223 pp., 16 text-figures and 5 plates. Price $4.50.

This is a book about a complex and difficult subject, the successful treatment of which calls for erudition and critical ability of a high order. Dr Kelley's treatment of this subject has certainly been comprehensive, and it is no mean feat to have condensed his wide reading into a straightforward account of some 180 pages. He has given fair representation to all the numerous hypotheses about the significance of the mycorrhizal habit. In the course of this account, he himself develops two particular theses, which he urges upon readers throughout the book. The first one is the need for a more thorough survey of the mycorrhizal habit as it occurs in nature. This is admirable, but one could wish that Dr Kelley had also impressed upon his readers the need for reliable quantitative methods, on a sound statistical basis, for collecting this most essential information; such methods are now being developed more widely for crop disease surveys. It is not sufficient to classify a species of plant as typically mycotrophic because a few plants growing in one or two scattered localities have been found with roots infected by a mycorrhizal fungus. In connexion with this particular thesis, Dr Kelley has made some rather sweeping statements, such as that at the beginning of chapter v: 'It is unknown whether plants in nature have root hairs or mycorrhizae,—or neither; but there is enough evidence at hand to indicate that mycorrhizae predominate over root hairs in the majority of cases.'

Dr Kelley's second thesis is that the nature of the mycorrhiza is determined by the host plant, and that the particular fungal symbiont is unimportant; this is perhaps his personal reaction against earlier and excessive claims for a narrow specificity of the mycorrhizal relationship. Although it is undeniable that one host plant may form mycorrhizas with a number of specialized mycorrhizal fungi, this is no argument against the specificity of the mycorrhizal relationship, nor is it any excuse for disregarding the special physiological attributes shown by some, at least, of the mycorrhizal fungi. Dr Kelley has completely ignored the significance of Melin's important work on the distinction between the carbon substrates of mycorrhiza formers and litter decomposers amongst the higher Basidiomycetes, to which fresh attention was so opportunely drawn by Harley in 1948 (*Biol. Rev.* **23**, 127). Dr Kelley has, in fact, fallen into the common error of many workers and writers on the mycorrhizal problem—an excessive preoccupation with the effect of the relationship on the host plant, and a corresponding neglect of its effect upon the parasite.

The best that can be said about this book is that it represents a fairly complete compilation of the voluminous literature about a highly controversial subject. It has the additional merit of being written in a simple, straightforward style, provided that one can ignore the pedagogic strictures about how research should be done, and the sometimes superficial criticisms, of a bystander who sees more of the game than the players.

S. D. GARRETT

Common British Fungi. By E. M. Wakefield and R. W. G. Dennis. (London: Gawthorne. 1950.) 290 pp., 6 text-figures and 111 coloured plates. Price 35*s*. net.

The buyers of this book certainly get full value for their money. It is surprising, with the high cost of colour printing, that it should have been possible at this price to produce 111 coloured plates illustrating in all some 470 species of fungi. The two authors and the publisher are to be congratulated on the completion of a remarkable work. Except for short references to other fungi in the general introduction, the book deals only with the hymenomycetes and gasteromycetes, though we think place should have been found for some of the more striking ascomycetes that the beginner is bound to meet with frequently. Agarics take up the greater part of the 290 pages of text, but sixty are devoted to the polypores, clavarias and other groups which are not usually so well represented in popular works. A valiant attempt has been made to produce a key to the genera without reference to microscopic characters and it will be interesting to know how this works out in practice. There are no keys to the species but this was hardly practicable. The authors do not depart from the traditional nomenclature as established by Fries, but they give useful indications of some modern tendencies. No authors' names are added to the binomials. For a popular work this is permissible though exceptions should have been made where the specific name has different interpretations. Had the authors been able to point to a modern work which they followed it would have made matters easier, but even the Revised List of Agarics and Boleti published in 1948 was ignored until the last moment when a few changes were referred to at the end of the introduction.

All the species illustrated are given short but adequate descriptions which include spore shape and measurements. When considered important, cystidia are also mentioned. Under the heading of each genus there is a preamble giving a fund of information. Practically all the common toadstools are described and figured but we should have liked to see a few more of the brightly coloured Boleti such as *Boletus satanas* and *B. calopus* which sometimes occur in large numbers. A few less common agarics are included, such as *Clitocybe expallens* which should have a subglobose spore, and *Mycena alba* (? Bres.) not yet in the British List.

The authors themselves are responsible for most of the coloured illustrations, and though these are not all up to the high standard which we expect from them, the general level is good. The exceptions may be accounted for by faulty reproduction but are more probably due to a too delicate conscience which forbade the inclusion of anything not painted by the authors from living specimens. Too often the material available was far from typical. We have had a succession of bad fungus years when even the commonest species were absent from our woods. This doubtless explains the untypical character of so many of the species illustrated. Even the experienced field mycologist would hardly recognize the following from the coloured figures: *Lepiota haematosperma*, with pink instead of dark blood-red gills; *Clitocybe aurantiaca*, without the rich orange gills; *C. distorta*, with no grooves on the stem; *C. vibecina*, with no striae on margin; *C. gigantea*, after a severe course of slimming; *Mycena pelianthina*, brick-coloured instead of livid purple; *Tricholoma fulvum* without yellow gills; *T. gambosum* looking like a faded *T. personatum*; *Pleurotus palmatus* with no veins on the cap; *Russula nigricans* hardly corresponding to the description; and so on. These are serious shortcomings, but on the other hand the book has so many excellent features that the beginner in the difficult but fascinating study of the fungi may be considered fortunate in possessing a work on such a generous scale which is not likely to be superseded for many years to come.

A. A. PEARSON

PROCEEDINGS, 1950

MEETINGS

Meeting held in the Department of Biology, Chelsea Polytechnic, London, S.W. 3, at 11.0 a.m., 21 January 1950. The President, Dr G. C. Ainsworth, in the Chair.

A. G. Morton. On the relation between nitrate and ammonia nutrition in moulds.
Miss A. Levy. Investigations of the physiology of ammonia nutrition in moulds.
P. J. Curtis and C. H. Unwin. Some antifungal substances produced by soil fungi.
E. G. Jeffreys and H. G. Hemming. Preliminary experiments on the stability of antibiotics in soil.
Miss J. M. Wright. A phytotoxic substance produced by *Alternaria solani*.
P. W. Brian. The effect of griseofulvin on the growth of fungi.

Meeting held in the Department of Biology, Chelsea Polytechnic, London, S.W. 3, at 11.30 a.m., 25 March 1950. The President, Dr G. C. Ainsworth, in the Chair.

Ascomycetes

A demonstration of fungi belonging to the Ascomycetes, with exhibits and comments by:

C. G. C. Chesters. Variation in *Diatrype stigma*; British species of *Anthostoma*; Ascomycetes from soil.
J. H. Warcup. Ascomycetes from soil.
Miss L. E. Hawker, Miss S. Mount, Miss V. O. Nicholls and B. E. J. Wheeler. Hypogaeous Ascomycetes.
S. J. Hughes. Some tropical 'sooty moulds'.
E. W. Mason and C. G. C. Chesters. British wood and bark Pyrenomycetes.
J. Webster. Pyrenomycetes of grass stems.

Meeting held in the Department of Botany, University of Reading, at 11.0 a.m., 26 July 1950. The President, Dr G. C. Ainsworth, in the Chair.

J. D. Blaxland. Moniliasis in turkeys.
Miss P. M. Stockdale. A note on the identification of *Candida* species.
R. E. Rewell. Mycotic infections of captive wild animals.
J. J. Bullen. Epizootic lymphangitis (*Histoplasma farciminosum*) in horses.
J. T. Duncan. The relation of mycoses of animals to disease in man.
Mrs D. Oxford. A note on human and bovine actinomycosis.

An account of this meeting is published in *Nature, Lond.*, 166, 547–9, 1950.

Meeting held in the Huxley Building, Imperial College of Science and Technology, London, S.W. 7., at 11.0 a.m., 20 October 1950. Joint meeting with the Association of Applied Biologists.

THE PLANT AND THE LAW

W. C. Moore. Introduction.
S. P. Wiltshire. Some repercussions arising from the exchange of plant material between countries.
A. P. Winsor. Inspection procedure in England.
F. G. W. Jones. Sugar beet eelworm order.
W. G. Keyworth. Verticillium wilt of hops order.
R. V. Harris. Some aspects of the certification schemes.

ANNUAL GENERAL MEETING, 1950

The fifty-fourth Annual General Meeting was held in the rooms of the Linnean Society of London, at 12 noon on Saturday, 2 December 1950, with the President, Dr G. C. Ainsworth, in the Chair.

After the Minutes of the previous Annual General Meeting had been read and signed the President recorded with deep regret the death of Prof. H. M. Fitzpatrick, of Cornell University, and of Miss E. F. Noel, a member of the Society since 1913. Dr Ainsworth then briefly reviewed the year's activities and referred with pleasure to the honours conferred on two members—on Miss Wakefield, who received the O.B.E., and on Dr Ramsbottom, who served as President of the Mycology Section of the 7th International Botanical Congress in Stockholm, and as President of the Medical Mycology Section of the 5th International Congress of Microbiology in Rio de Janeiro. To Dr Ramsbottom the President extended the Society's good wishes in his retirement.

The Treasurer, W. Buddin, then presented his annual statement, in which he acknowledged a grant to the Society of £200 by the Royal Society.

The following Officers and new Members of the Council for 1951 were then elected: *President*, P. H. Gregory; *Vice-Presidents*, F. A. Sowter, and the two past-Presidents, W. P. K. Findlay and G. C. Ainsworth; *Secretary*, C. J. Hickman; *Foray Secretary*, G. Smith; *Treasurer*, W. Buddin; *Editors*, P. H. Gregory and W. C. Moore; *Members of the Council*, P. D. Orton, I. F. Storey and J. Webster (to replace T. E. T. Bond, Miss M. P. English and E. R. Wallace). C. C. V. Batts, W. J. Dowson and S. J. Hughes were elected as new members of the Plant Pathology Committee.

On a motion from the Chair, Dr B. Barnes was elected as an Honorary Member. Eleven new Members and five new Associates were elected, making a total of forty-eight new Members and twenty new Associates for the year.

The Secretary outlined proposals for the 1951 programme, which were approved. The meeting then adopted a resolution protesting against a proposal to take over Newborough Warren, Isle of Anglesey, as a bombing range.

After a vote of thanks to the Officers the meeting adjourned until 2.30 p.m., when the President delivered his address, 'A century of medical and veterinary mycology in Britain'. A vote of thanks to Dr Ainsworth, proposed by Dr J. T. Duncan and seconded by W. Buddin, concluded the meeting.

C. J. Hickman, *Secretary*

RECEIPTS AND PAYMENTS
for the year ended 30 June 1950

Receipts	£	s.	d.	£	s.	d.
1 July 1949, Balance brought forward				1240	11	7
Cambridge University Press:						
Sale of *Transactions*:						
Vol. xxxii	532	3	0			
Back Volumes	431	18	5			
Reprints	74	8	6	1038	9	11
Sale of *List of Common Names*				14	12	6
Sale of *Diseases of British Grasses*				1	14	2
Sale of *Transactions* (direct)				9	10	0
Sale of Publications at Meetings				16	11	0
Grant from Royal Society towards production, new edition *Diseases of British Grasses*				200	0	0
Subscriptions:						
Current	475	10	0			
In advance	8	15	0			
Associates	16	19	0	501	4	0
Executors of Miss E. M. Lister				300	0	0
Donations:						
Printing Fund	112	0	0			
Cheesman, Pethybridge and Library Funds	3	0	0			
Hospitality Fund*	8	17	6	123	17	6
Interest:						
Capital Reserve Fund	38	3	9			
Post Office Savings Bank	19	3	6	57	7	3
Income Tax repayment				69	8	4
Adjustment on balance due from N.Y. Bank				6	5	11
				£3579	12	2

Payments	£	s.	d.	£	s.	d.
Cambridge University Press:						
Cost of production of *Transactions*:						
Volume xxxii (800 copies) and reprints				1200	16	8
Purchase of *Transactions*, reprints, etc.				8	18	6
Grants:						
Cheesman and Pethybridge Funds	16	0	0			
Hospitality Fund*		13	9	16	13	9
Subscriptions:						
Woolhope Club	1	0	0			
Biological Council	4	4	0			
Council for Promotion of Field Studies	1	1	0			
Society for Promotion of Nature Reserves	2	0	0	8	5	0
Purchase of £125 of 3½% War Stock				112	0	9
Postages, Stationery, etc.				49	12	4
Sundry Printing				34	17	9
Fees for Meetings				7	15	6
Balance:						
At Midland Bank	703	14	10			
In Post Office Savings Bank	1436	17	1	2140	11	11
				£3579	12	2

*A special grant of £20 from the British Council was paid direct to foreign guest.

CAPITAL RESERVE FUND ACCOUNT (*incorporating the Cheesman, Pethybridge and Printing Funds*)

Nominal values of Stock			
	3½% *War Stock*	£625	*Total* £1325
	3% *Defence Bonds*	£200	
	2½% *Defence Bonds*	£500	

Examined and found correct, *W. C. MOORE*, 23 August 1950.

WALTER BUDDIN, *Hon. Treasurer.*

THE TOTNES FORAY

12–14 May 1950

By G. C. AINSWORTH

The thirty-first Spring Foray, which was held at Totnes, Devon, from 12 to 14 May 1950, with headquarters at the Seymour Hotel, was attended by about twenty members and friends.

On Friday, 12 May, the Dartington Hall estate was visited. North Wood and Staverton Ford Plantation were worked, and on the way back to Totnes the party was received at Dartington Hall and shown round the gardens by Mr L. K. Elmhirst. Next day there was an excursion to Dartmoor in ideal weather. After an hour and a half's collecting at New Bridge a move was made to Dartmeet for lunch and then on, via Three Bridges and Postbridge, to Warren House Inn. From there, most members made a traverse of the moor to Grim's Pound; the return to Totnes being by way of Widdecombe, Heytor and Bovey Tracey. The final outing, on Sunday 14 May, was to Berry Pomeroy castle and woods about three miles to the east of Totnes.

There was a short business meeting on the Saturday evening at which the President drew attention to an exhibit of notebooks containing water colour drawings of Devon fungi by Edward Parfitt [1820–93] which Mr F. A. Brokenshire had recently presented to the Department of Botany, University College, Exeter, and a locality for the 1951 Spring Foray was discussed.

The collections call for little comment. A good and representative series of rusts was found, *Entyloma ficariae* on *Ranunculus auricomus* (Herb. Kew.) appears to be a new British host record, while the aquatic fungi listed reflect the interests of Miss Waterhouse and of Dr J. T. Middleton of Riverside, California, who was a most welcome visitor.

The Society's thanks are due to the Dartington Hall Trustees and to the Duke of Somerset for permission to collect on their estates and to Mr H. R. Hide of Dartington Woodlands for maps and much other guidance in arranging the foray. All members present contributed to the records, but special thanks must be given to Mr A. A. Pearson and Miss G. M. Waterhouse, and to Mr Andrew Angus for his assiduous collecting and for much help in examining the material.

List of species recorded

B. = Berry Pomeroy; *D.* = Dartmeet; *DH.* = Dartington Hall; *GP.* = Grim's Pound; *NB.* = New Bridge; *T.* = Totnes (garden of the Seymour Hotel, etc.).

BASIDIOMYCETES

HYMENOMYCETES AND GASTEROMYCETES

(Names from Pearson and Dennis, *Trans. Brit. mycol. Soc.* **31**, 145–90, 1948; or Rea, *British Basidiomycetae*, 1922.)

Amanita excelsa, *NB.*, rubescens, *DH.*
Amanitopsis fulva, *NB.*
Collybia butyracea, *NB.*, dryophylla, *Dartmoor*, platyphylla, *DH.*
Coprinus micaceus, *DH.*, plicatilis, *D.*
Hypholoma candolleanum, *B.*
Lenzites betulinus, *DH.*
Omphalia fibula, *NB.*, umbellifera, *NB.*
Panus stipticus, *DH.*
Pholiota praecox, *T.*
Pluteus cervinus, *DH.*; var. patricius, *T.*
Stropharia albocyanea, *B.*

Fomes annosus, on *Picea*, *DH.*, on *Larix*, *B.*
Ganoderma applanatum, *DH.*
Polystictus versicolor, *NB.*, *B.*

Stereum hirsutum, *NB.*

Auricularia auricula-judae, on *Sambucus*, *B.*

Lycoperdon saccatum, *DH.*, *NB.*
Mutinus caninus, *DH.*

UREDINALES

Coleosporium senecionis Fr., on *Senecio vulgaris*, *B.*, ? I, on *Pinus sylvestris*, *B.*
Melampsora rostrupii Wagn., on *Mercurialis perennis*, *DH.*, *NB.*
Milesina blechni Syd., on *Blechnum spicant*, *GP.*
Phragmidium violaceum Wint., on *Rubus*, *DH.*, *B.*
Puccinia annularis on *Teucrium*, *NB.*, anthoxanthae Fuckel, on *Anthoxanthum odoratum*, *DH.*, antirrhini Diet. & Holw., *T.*, bromina Eriks., on *Bromus sterilis*, *B.*, buxi DC., *B.*, caricis Reb., I, on *Urtica dioica*, *B.*, cirsii Lasch., on *Cirsium vulgare*, *DH.*, fusca Wint., on *Anemone nemorosa*, *B.*, iridis Wallr., on *Iris foetidissima*, *B.*, lapsanae Fuckel, *B.*, lolii Niels., on *Arrhenatherum elatius*, *B.*, on *Holcus lanatus*, *DH.*, lychnidearum Link, on *Melandrium dioicum*, *DH.*, malvacearum Mont., *B.*, obscura Schroet., on *Luzula sylvatica*, *DH.*, *NB.*, *Dartmoor*, phalaridis Plowr., on *Arum maculatum*, *DH.*, *B.*, primulae Duby, on *Primula vulgaris*, *DH.*, *B.*, pringsheimiana Kleb., on *Ribes uva-crispa*, mine working near *Warren House Inn*, saniculae Grev., on *Sanicula europaea*, *DH.*, *B.*, sonchi Rob., on *Sonchus oleraceus*, *B.*, suaveolens (Lév.) Rost., on *Cirsium arvense*, *B.*, taraxaci Plow., *DH.*, umbilici Guep., on *Umbilicus pendulinus*, *DH.*, *D.*, *B.*, vincae Berk., on *Vinca major*, *B.*, violae DC., *DH.*, winteriana Magn., on *Allium ursinum*, *DH.*
Triphragmium ulmariae Wint., on *Filipendula ulmaria*, *DH.*
Uredo scolopendrii Schroet., on *Phyllitis scolopendrium*, *B.*
Uromyces ficariae Lév., on *Ranunculus ficaria*, *DH.*, poae Rab., on *R. ficaria*, *NB.*, *B.*, scillarum Wint., on *Scilla non-scripta*, *DH.*, *NB.*, *B.*, *D.*

USTILAGINALES

Entyloma ficariae (Berk.) Fisch. v. Waldh., on *Ranunculus auricomus*, *DH.*, on *R. ficaria*, *DH.*, *NB.*, *B.*
Urocystis anemones (Pers.) Wint., on *Anemone nemorosa*, *DH.*, *B.*
Ustilago violacea (Pers.) Rous., on *Melandrium dioicum*, *DH.*, *NB.*

ASCOMYCETES

PYRENOMYCETES

Daldinia concentrica (Fr.) Ces. & de Not., *B.*
Diatrype stigma (Fr.) Fr., on *Corylus*, *NB.*
Elaphomyces muricatus Fr. *B.*
Epichloe typhina (Fr.) Tul., on *Dactylis glomerata*, *DH.*, *NB.*, on *Poa trivialis*, *DH.*, *NB.*, *B.*
Erysiphe graminis DC., on *Agropyron repens*, *B.*, on *Milium effusum* and *Poa trivialis*, *DH.*
Hypoxylon coccineum Bull., on *Fagus*, *DH.*, fuscum (Fr.) Fr., *NB.*
Mycosphaerella rumicis (Desm.) Grove, *NB.*
Nectria cinnabarina (Fr.) Fr., on *Fagus*, *DH.*

Oidium quercinum Thüm., *DH.*, *NB.*
Stigmatea robertiani (Fr.) Fr., *DH.*, *D.*, *B.*
Xylaria carpophila (Fr.) Fr., *DH.*, *B.*

Discomycetes

Bulgaria inquinans (Pers.) Fr., *D.*
Dasyscypha calycina (Schum.) Boud., on *Larix*, *D.*
Mitrula paludosa Fr., *NB.*, *Dartmoor.*
Phacidium multivalve (DC.) Kunze & Schm., on *Ilex*, *DH.*
Pseudopeziza trifolii (Fr.) Fuckel, on *Trifolium repens*, *DH.*
Sclerotinia curreyana Berk., on *Juncus*, *Dartmoor.*
Stegia ilicis Fr., *DH.*
Tapesia fusca (Fr.) Fuckel, on *Calluna*, *D.*
Gyrocratera ploettneriana P. Henn, *DH.*

Taphrinales

Protomyces macrosporus Ung. on *Aegopodium podagraria*, *D.*

PHYCOMYCETES

Endogone lactiflua B. & Br., *DH.*
Olpidium luxurians (Tom.) Fisch, on pollen in river Dart, *T.*
Pilobolus sp., *NB.*
Plasmopara nivea Schroet., on *Conopodium majus*, *NB.*, pygmaea (Ung.) Schroet., on *Anemone nemorosa*, *NB.*
Pythium megalocanthum de Bary, *NB.*, undulatum Peters., *NB.*, *T.*
Synchytrium taraxaci de Bary & Woronin., *DH.*, *NB.*, *B.*

FUNGI IMPERFECTI

Articulospora tetracladia Ing., *NB.*, *T.*
Heterosporium gracile (Wallr.) Sacc., on *Iris*, *DH.*
Lemoniera aquatica de Willd., *NB.*, *T.*
Mastigosporium album Riess, on *Dactylis*, *DH.*, *B.*
Phyllosticta hedericola Dur. & Mont., *DH.*
Pycnostysanus azaleae (Peck) Mason, on *Rhododendron*, *D.*
Ramularia pratensis Sacc., on *Rumex*, *NB.*, variabilis Fuckel, on *Digitalis*, *DH.*, *D.*
Rhopographus filicinus (Fr.) Fuckel, on *Pteridium aquilinum*, *NB.*
Scolecotrichum graminis Fuckel, on *Poa trivialis*, *B.*
Septoria anemones Desm., *DH.*, hederae Desm., *B.*, lychnidis Desm., on *Melandrium dioicum*, *DH.*, *D.*, oxyspora Penz. & Sacc., on *Poa trivialis*, *B.*, quevillensis Sacc., on *Filipendula ulmaria*, *DH.*, *D.*, rhododendri Cooke, *D.*
Tetrachaetum elegans Ing., *NB.*
Tetracladium setigerum (Grove) Ing., *T.*
Tricladium splendens Ing., *NB.*

MYXOMYCETES

Lycogala epidendrum Adans., *DH.*, *NB.*

Specimens supporting many of the records have been deposited in the herbarium of the Department of Botany, University College, Exeter. Others are in the herbarium of the Commonwealth Mycological Institute, Kew.

THE BANGOR FORAY

11–18 September 1950

By G. SMITH, *Foray Secretary*

The forty-sixth Autumn Foray was held at Bangor, Caernarvonshire, anc was attended by between seventy and eighty members. Working headquarters were in the botanical laboratories of University College and mos of the party were accommodated at University Hall.

After the experience of the dry conditions, and consequent dearth o agarics, at Oxford in 1949 it was gratifying to see the long benches of the main laboratory covered with specimens, to the bewilderment of a numbe of beginners and to the embarrassment of the experts who were trying to identify all the finds. For the first time a number of recorders were appointed, each responsible for a particular group of fungi, with the objec of facilitating the compilation of the final list and of ensuring that records were as complete as possible, and, on the whole, the system worked well. Nevertheless, the Foray Committee is of the opinion that, in a good year for collecting, it is still possible for interesting specimens to be thrown away without having been properly examined. The Committee, therefore, intends to suggest, before the next Autumn Foray, a number of further improvements in the methods of recording.

Compared with last year the list of micro-fungi is short, this being due, not to any dearth of these fungi, but to the lack of enthusiasts for collecting and identifying them. On the other hand, a small but devoted band of truffle-hunters have contributed valuable records. Their assiduous scratching attracted some good-natured chaffing from the uninitiated but their finds aroused much interest.

On Monday evening, by which time most of the party had assembled, there was an informal social gathering at University College. The first foray was to Vaynol Park and Nant-y-garth woods, where good collections were made, particularly of species of *Hygrophorus* and *Inocybe*. The following day the woods alongside the river near Bettws-y-Coed were visited and proved to be well stocked with fungi, species of *Clavaria*, particularly *C. cinerea* and *C. rugosa* being especially plentiful. The most interesting find was *Inocybe pudica* Kühner, new to Britain, growing in abundance under spruce. On Thursday a half-day excursion to Nant Heilyn woods resulted in further large collections, including many species of *Hygrophorus* and *Cortinarius*. Cwm Idwal was visited on Friday and here the party split into three, the first, and most energetic, ascending to the Devil's Kitchen, the second making a circuit of the lake, and the third attempting to work the grassy slopes. Heavy rain set in and there was a comparative scarcity of fungi, with the result that most of the party returned to Bangor before the scheduled time. A few members left the coaches at Half-way Bridge, in order to explore the woods within easy reach, and these returned with full baskets. The last of the organized forays was to the sand dunes of Newborough Warren, Anglesey. Again fungus-hunting was curtailed by the onset of heavy rain and a foretaste of the gale which swept the country during the following night. However, fungi were abundant, two species being of particular interest. There were hundreds of sporophores of a handsome species of *Lepiota*. Some of these could be identified as typical *L. excoriata*, others were equally typical *L. mastoidea*, whilst still others showed every gradation between the two species, raising the obvious question as to whether the two should be regarded as distinct. The other interesting find was *Lactarius controversus*, a species usually associated with poplars, but, in this case, occurring in large numbers amongst *Salix repens*.

A General Meeting of the Society was held on 14 September, when the question of the locality to be visited in 1951 was discussed without any definite decision being reached. On the motion of the Foray Secretary votes of thanks were passed with acclamation to those who had contributed to the success of the Foray: to Sir Michael Duff for permission to visit Vaynol Park and Nant-y-garth; to Lady Janet Harper for permission to work Nant Heilyn woods; to Prof. P. W. Richards for his kindness in putting the botanical laboratories at the disposal of the Society; to Dr Martin and Miss Mence of University Hall for providing excellent accommodation; and to Dr and Mrs Dobbs, who had undertaken the onerous task of making all local arrangements for the Foray.

On Friday evening Dr F. B. Hora gave a stimulating talk on 'Simple methods of preparing agarics for microscopical examination', followed by an animated discussion. After the meeting Mr John Brooke gave a much appreciated display of coloured slides of agarics, including a number showing African species quite unlike anything found in this country.

List of species recorded

B. = Bettws-y-Coed; *C.* = Caernarvon; *H.* = Nant Heilyn; *Hd.* = Holyhead; *Hw.* = Halfway woods; *I.* = Cwm Idwal; *N.* = Newborough Warren; *Ng.* = Nant-y-garth; *V* = Vaynol Park.

Some members did not keep apart their morning and afternoon collections on Tuesday. The records for Vaynol Park may, therefore, include a few species found at Nant-y-garth.

Names without author citations for Agaricales are taken from Pearson and Dennis, *Trans. Brit. mycol. Soc.* **31**, 145–90, 1948, and for other groups of Basidiomycetes from Rea, *British Basidiomycetae*, 1922. * indicates new record for Britain.

PHYCOMYCETES

Bremia lactucae Regel, on *Senecio vulgaris*, *B.*
Endogone lactiflua Berk., *B.*, *H.*, *N.*, microcarpa Tul., *V.*
Empusa muscae (Fr.) Cohn, on house-fly; on bluebottle on *Phallus impudicus*, *N.*
Peronospora alta Fuckel, on *Plantago major*, *B.*, linariae Fuckel, on *Linaria cymbelaria*, *B.*, sordida B. & Br., on *Scrophularia nodosa*, *Hw.*, verna Gäum., on *Veronica serpyllifolia*, *B.*
Phytophthora infestans (Mont.) de Bary, on potato, *H.*

ASCOMYCETES

PLECTOMYCETES

Elaphomyces granulatus Fr., *B.*, *N.*, muricatus Fr., *N.*, *V.*
Phyllactinia corylea (Pers.) Karst., on *Betula*, *Hw.*, on *Corylus*, *Hw.*
Uncinula aceris (DC.) Sacc., on *Acer*, *H.*, salicis (DC.) Wint., on *Salix repens*, *N.*

PYRENOMYCETES

Anthostoma turgidum (Pers. ex Fr.) Tul., on *Fagus*, *V.*
Anthostomella ammophilae (Phil. & Plowr.) Sacc., on *Ammophila*, *N.*
Berlesiella nigerrima (Bloxam & Currey) Sacc., on *Diatrype stigma*, *V.*
Bertia moriformis (Tode ex Fr.) de Not., on *Fagus*, *V.*
Chaetosphaeria phaeostroma (Dur. & Mont.) Fuckel, on *Diatrype stigma*, *V.*
Chromocrea gelatinosa (Tode ex Fr.) Seaver, on old *Juncus* stems, *N.*
Claviceps purpurea (Fr.) Tul., *B.*
Cordyceps capitata (Holmsk. ex Fr.) Link, on *Elaphomyces*, *B.*, militaris (Linn. ex Fr.) Link, *I.*, *V.*
Cryptospora suffusa (Fr.) Tul., on *Alnus*, *H.*
Diaporthe leiphaemia (Fr.) Sacc., on *Quercus*, *B.*
Diatrype stigma (Hoffm. ex Fr.) Fr., on *Fagus*, *B.*, *H.*, *V.*
Diatrypella favacea (Fr.) Ces. & de Not., on *Betula*, *B.*, on *Fagus*, *V.*, quercina (Pers. ex Fr.) Fuckel, on *Quercus*, *Ng.*
Echidnodes aulographoides (Bomm., Rouss. & Sacc.) Robertson, on *Rhododendron*, *V.*
Eutypa flavovirens (Pers. ex Fr.) Tul., on *Fagus*, *V.*
Gloniopsis levantica Rehm, on *Rubus*, *Ng.*
Hypoderma virgultorum DC., on *Rhododendron*, *Ng.*
Hypoxylon coccineum Bull., on *Betula*, *Ng.*, on *Fagus*, *Ng.*, fuscum (Pers. ex Fr.) Fr., on *Corylus*, *B.*, on *Alnus*, *H.*, multiforme (Fr.) Fr., on *Betula*, *Ng.*, rubiginosum (Pers. ex Fr.) Fr., on *Fraxinus*, *B.*
Hysterium angustatum (Alb. & Schw. ex Fr.) Chev., on *Fraxinus*, *B.*
Leptosphaeria littoralis Sacc., on *Ammophila*, *N.*
Melanconis stilbostoma (Fr.) Tul., on *Betula*, *B.*
Melanomma pulvis-pyrius (Pers. ex Fr.) Fuckel, on *Fagus*, *H.*
Nectria cinnabarina (Tode ex Fr.) Fr., on *Sambucus*, *B.*, *H.*, *V.*
Ophiostoma piceae (Münch) Syd., on *Quercus*, *B.*
Phyllachora graminis (Pers. ex Fr.) Fuckel, on *Dactylis*, *Hw.*, *V.*
Quaternaria quaternata (Pers. ex Fr.) Schroet., on *Fagus*, *H.*
Rhopographus filicinus (Fr.) Fuckel, *B.*
Stigmatea robertiani (Fr.) Fr., on *Geranium robertianum*, *Hw.*
Trichosphaeria myriocarpa (Fr.) Petrak & Sydow, on *Fagus*, *V.*
Xylaria carpophila Fr., *V.*, hypoxylon (Linn. ex Fr.) Grev., on *Fagus*, *B.*, *Ng.*, *V.*, polymorpha (Pers.) Grev., *B.*, *V.*

DISCOMYCETES

Aleuria vesiculosa (Bull.) Boud., *B.*
Arachnopeziza aurelia Fuckel, on *Picea*, *B.*
Bulgaria inquinans (Pers.) Fr., on *Fagus*, *Ng.*, on *Quercus*, *B.*
Calycella citrina (Hedwig) Oud., *V.*
Chlorosplenium aeruginosum (Oeder) de Not., on *Betula*, *B.*
Ciliaria scutellata (Linn.) Quél., *Ng.*
Coccomyces coronatus (Schum.) de Not., on *Quercus*, *B.*, dentatus (Kunze & Schum.) Sacc., on *Quercus*, *B.*
Coryne sarcoides (Jacq.) Tul., *B.*, *V.*, urnalis (Nyl.) Sacc., on *Betula*, *B.*
Dasyscypha acuum (Alb. & Schw. ex Fr.) Sacc., on pine needles, *N.*, ciliaris (Schrad.) Sacc., on oak leaves, *B.*, inquilina (Karst.) Wint., on *Equisetum*, *N.*, nivea (Hedwig ex Fr.) Sacc., pudibunda (Quél.) Sacc., *V.*, sulphurea (Pers. ex Fr.) Mass., on *Urtica*, *N.*, virginea (Batsch ex Fr.) Fuckel., wilkommii (Hartig) Boud., on *Larix*, *B.*, *H.*, *V.*
Geoglossum hirsutum (Pers.) Boud., *N.*
Helotium fagineum (Pers.) Fr., on *Fagus*, *Ng.*, phyllophilum (Desm.) Karst., on *Fagus*, *Ng.*, scutula (Pers.) Karst., *N.*, virgultorum (Wahl.) Karst.
Helvella crispa (Scop.) Fr., *B.*, *V.*, elastica Bull., *V.*, lacunosa Afz., *V.*, sulcata Afz., *B.*
Leotia lubrica (Scop.) Fr., *Ng.*
Lophodermium rhododendri Ces.
Macropodia macropus (Pers. ex Fr.) Fuckel, *B.*
Ombrophila faginea (Pers. ex Fr.) Boud., on beech mast, *Ng.*

Orbilia xanthostigma Fr., *B.*

Otidea leporina (Batsch) Fuckel.

Peziza aurantia Pers., *V.*, badia Pers., *V.*

Rhytisma acerinum Fr., *B.*, *V.*

Rutstroemia firma Pers., on *Quercus*, *H.*

Sepultaria arenicola Lév., *N.*, arenicola Lév. var. Bloxami Cooke, *N.*, hirta (Schum.) Boud., *B.*

Tuberales

Balsamia platyspora Berk., *V.*

Genea verrucosa Vitt., *V.*

Hydnotrya tulasnei B. & Br., *H.*

Tuber aestivum Vitt., *V.*, puberulum Berk. & Br., *B.*, *V.*, rufum Pico, *B.*, *V.*

BASIDIOMYCETES

Ustilaginales

Sphacelotheca hydropiperidis (Schum.) de Bary, *Ng.*

Ustilago violacea (Pers.) Roussel, on *Melandrium dioicum*, *Ng.*

Uredinales

Coleosporium campanulae Lév., on *Campanula rotundifolia*, *I.*, senecionis Fr., on *Senecio vulgaris*, *Hd.*, *N.*, tussilaginis Tul., on *Tussilago farfara*, *Hd.*

Kuehneola albida Magn., *Ng.*

Melampsora hypericorum Wint., on *Hypericum androsaemum* and *H. cernuum*, *V.*

Melampsoridium betulinum Kleb., *B.*

Milesina dieteliana Magn.

Phragmidium fragariastri Schröt., *Ng.*, violaceum Wint., *B.*, *H.*, *N.*, *Ng.*

Puccinia acetosae Körn., *B.*, agropyrina Erikss., on *Agropyron repens*, *H.*, *Hd.*, *N.*, annularis Schlecht., *H.*, *Ng.*, arrhenatheri Erikss., *Hd.*, baryi Wint., *Ng.*, behenis Otth., on *Melandrium dioicum*, *Ng.*, centaureae DC., *B.*, chaerophylli Purt., on *Anthriscus sylvestris*, *N.*, chrysosplenii Grev., *Ng.*, circaeae Pers., *B.*, *Ng.*, on *Circaea intermedia*, *H.*, coronata Corda, on *Holcus lanatus*, *B.*, *H.*, *Ng.*, on *Festuca ovina*, *I.*, on *Lolium perenne*, *N.*, *Ng.*, glechomatis DC., *B.*, *N.*, *Ng.*, hieracii Mart., *I.*, on *Hieracium murorum*, *Hw.*, hypochoeridis Oud., *N.*, lapsanae Fuckel, *B.*, *I.*, lychnidearum Link, on *Melandrium dioicum*, *Ng.*, malvacearum Mont., *Hd.*, *N.*, menthae Pers., *N.*, *Ng.*, obscura Schröt., aecidia on *Bellis perennis*, *N.*, teleutospores on *Luzula sylvatica*, *I.*, *Ng.*, obtegens Tul., *I.*, *N.*, *Ng.*, smyrnii Corda, *C.*, sonchi Rob., *B.*, *N.*, taraxaci Plowr., *B.*, *I.*, umbilici Guep., *N.*, violae DC., *B.*, *V.*, zopfii Wint., *N.*

Pucciniastrum circaeae Speg., *B.*, *Ng.*, on *Circaea lutetiana*, *H.*

Uromyces alchemillae Lév., *I.*, polygoni Fuckel, *Hd.*

Agaricales

Amanita citrina, *B.*, *Hw.*, *V.*, citrina var. alba, *B.*, *Hw.*, excelsa, *H.*, *Hw.*, muscaria *B.*, *Hw.*, *V.*, pantherina, *H.*, *Hw.*, *V.*, phalloides, *Hw.*, *V.*, porphyria, *B.*, rubescens, *B.*, *H.*, *Hw.*, *Ng.*, *V.*

Amanitopsis fulva, *B.*, *Hw.*, inaurata, *V.*, nivalis, *V.*, vaginata, *B.*, *H.*, *V.*

Anellaria semi-ovata, *Hw.*, *I.*

Armillaria mellea, *B.*, *Hw.*, *I.*, *Ng.*, *V.*, mucida, *V.*

Bolbitius vitellinus, *N.*

Boletus badius, *B.*, *Hw.*, *Ng.*, *V.*, bovinus, *V.*, calopus, *Hw.*, *Ng.*, *V.*, chrysenteron, *B.*, *H.*, *Hw.*, *N.*, *V.*, edulis, *B.*, *Hw.*, *Ng.*, *V.*, elegans, *B.*, *H.*, *V.*, erythropus, *V.*, felleus, *V.*, granulatus, *V.*, luridus, *V.*, piperatus, *N.*, pulverulentus, *I.*, scaber, *B.*, *Hw.*, *V.*, subtomentosus, *B.*, *H.*, *Hw.*, *Ng.*, *V.*, variegatus, *B.*, versicolor, *N.*, versipellis, *B.*

Cantharellus cibarius, *B.*, *H.*, *Hw.*, *V.*, cinereus, *B.*, cupulatus, *I.*, tubaeformis, *B.*

Clitocybe aurantiaca, *B.*, *H.*, *V.*, aurantiaca v. albida, *Hw.*, aurantiaca v. nigripes, *B.*, brumalis, *N.*, clavipes, *B.*, *H.*, ditopus, *H.*, flaccida, *V.*, fragrans, *B.*, *N.*, infundibuliformis, *Hw.*, infundibuliformis v. alba, *B.*, *V.*, nebularis, *H.*, *V.*, rivulosa, *N.*

Clitopilus prunulus, *H.*, *V.*

Collybia ambusta, *I.*, butyracea, *B.*, *H.*, *V.*, clusilis, *H.*, coracina, *U.*, distorta, *B.*, *H.*, *Hw.*, *V.*, fusipes, *H.*, maculata, *B.*, *V.*, platyphylla, *V.*, radicata, *V.*, rancida, *B.*, *Hw.*

Coprinus comatus, *V.*, micaceus, *H.*, *Hw.*, *V.*, plicatilis, *N.*, sterquilinus, *U.*

Cortinarius anomalus, *H.*, *Hw.*, *N.*, *V.*, anthracinus, *B.*, azureus, *H.*, balaustinus, *B.*, bolaris, *B.*, caninus, *N.*, cinnamomeus, *B.*, *H.*, collinitus, *N.*, croceo-comus, *N.*, crystallinus, *Hw.*, delibutus, *Hw.*, *I.*, elatior, *B.*, *Hw.*, *V.*, erythrinus, *Ng.*, *V.*, flexipes, *B.*, *H.*, *Ng.*, hemitrichus, *B.*, hinnuleus, *B.*, *V.*, leucopus, *B.*, *V.*, obtusus, *B.*, *Hw.*, orellanus, *B.*, phoeniceus, *H.*, pholideus, *B.*, *I.*, raphanoides, *B.*, rigidus, *B.*, *H.*, sanguineus, *H.*, scandens, *B.*, semisanguineus, *H.*, torvus, *B.*, *Hw.*, *V.*, triformis, *N.*, *V.*, venetus, *V.*

Craterellus sinuatus, *B.*, *Hw.*, *I.*

Crepidotus mollis, *B.*, sphaerosporus, *Ng.*

Crinipellis stipitarius, *N.*

Entoloma lividum, *V.*, nidorosum, *B.*, *V.*, porphyrophaeum, *U.*, *V.*, rhodopolium, *Hw.*, sericeum, *V.*

Flammula alnicola, *B.*, sapinea, *B.*, *Ng.*, *V.*, scamba, *B.*

Galera badipes, *H.*, *coprophila Kühner, *I.*, hypnorum, *B.*, *H.*, *I.*, *N.*, *V.*, mniophila, *I.*, mycenopsis, *I.*, *pubescens Gillet, *H.*, *N.*, rubiginosa, *I.*

Gomphidius glutinosus, *B.*, *V.*, rutilans, *V.*

Gyroporus castaneus, *V.*

Hebeloma crustuliniforme, *N.*, *Ng.*, mesophaeum, *H.*, *N.*, sacchariolens, *B.*

Hygrophorus calyptraeformis, *H.*, ceraceus, *H.*, chlorophanus, *B.*, *H.*, *I.*, *N.*, *V.*, coccineus, *Hw.*, *I.*, *N.*, *V.*, conicus, *B.*, *H.*, *I.*, *V.*, *constans Lange non Murrill, *N.*, fornicatus, *H.*, intermedius, *V.*, lacmus, *I.*, laetus, *H.*, *I.*, metapodius, *I.*, *V.*, miniatus, *V.*, nitratus, *I.*, obrusseus, *H.*, pratensis, *H.*, *I.*, psittacinus, *H.*, *I.*, *V.*, sciophanus, *V.*, sciophanoides, *U.*, turundus, *H.*, unguinosus, *H.*, *Hw.*, *U.*, *V.*, virgineus, *B.*, *H.*, *Hw.*, *V.*

Hypholoma candolleanum, *N.*, capnoides, *V.*, dispersum, *B.*, elongatum, *I.*, fasciculare, *B.*, *H.*, *Hw.*, *V.*, hydrophilum, *V.*, radicosum, *B.*, *H.*, *Hw.*, sublateritium, *B.*, *V.*, velutinum, *V.*

Inocybe asterospora, *I.*, *V.*, auricoma, *B.*, *V.*, brunnea, *N.*, calamistrata, *B.*, *Hw.*, *V.*, descissa v. brunneo-atra, *Hw.*, *N.*, dulcamara, *N.*, eutheles, *B.*, *V.*, fastigiata, *N.*, *V.*, geophylla, *B.*, *V.*, godeyi, *N.*, haemacta, *V.*, maculata, *B.*, *V.*, napipes, *V.*, obscura, *B.*, petiginosa, *B.*, *N.*, praetervisa, *H.*, *V.*, *pudica Kühner (= I. rubescens Lange), *B.*, *N.*, scabella, *V.*, serotina, *N.*, umbrina, *H.*

Laccaria laccata, everywhere, laccata v. amethystina, *B.*, *H.*, *Hw.*, *V.*

Lactarius blennius, *V.*, camphoratus, *B.*, *H.*, chrysorheus, *B.*, controversus, *N.*, deliciosus, *I.*, *V.*, fuliginosus, *B.*, *V.*, glyciosmus, *B.*, *Hw.*, *V.*, hepaticus, *B.*, insulsus, *V.*, lilacinus, *B.*, mitissimus, *Hw.*, *V.*, pallidus, *V.*, plumbeus, *B.*, *H.*, *Hw.*, *V.*, pyrogalus, *B.*, *H.*, *V.*, quietus, *B.*, *Hw.*, *V.*, rufus, *Hw.*, *V.*, serifluus, *B.*, *I.*, *V.*, spinosulus, *B.*, subdulcis, *B.*, *I.*, tabidus, *B.*, torminosus, *B.*, *Hw.*, vellereus, *Hw.*, vietus, *B.*, volemus, *Hw.*, *I.*

Lepiota amianthina, *B.*, *H.*, *I.*, brebissonii, *Ng.*, castanea, *B.*, clypeolaria, *B.*, *N.*, cristata, *B.*, *N.*, *V.*, excoriata, *N.*, felina, *V.*, granulosa, *V.*, haematosperma, *B.*, *V.*, procera, *Hw.*, rhacodes, *H.*, *V.*

Leptonia aethiops, *B.*, asprella, *B.*, *I.*, *V.*, chalybaea, *V.*, lampropus, *V.*, sericella, *B.*, *I.*, serrulata, *V.*

Leptotus muscigenus, *N.*

Marasmius androsaceus, *B.*, *H.*, *I.*, ceratopus, *N.*, *V.*, confluens, *B.*, *H.*, *Hw.*, *N.*, *V.*, dryophilus, *B.*, *N.*, *V.*, esculentus, *V.*, oreades, *N.*, peronatus, *B.*, *V.*, ramealis, *B.*, *H.*, rotula, *B.*, *V.*

Mycena alcalina, *V.*, amicta, *B.*, *H.*, *V.*, ammoniaca, *V.*, epipterygia, *H.*, *I.*, flavo-alba, *I.*, galericulata, *B.*, *H.*, galopus, *H.*, *N.*, *V.*, metata, *H.*, *V.*, olida, *H.*, polygramma, *B.*, *V.*, pura, *H.*, *Hw.*, *N.*, *V.*, rorida, *B.*, rubromarginata, *B.*, sanguinolenta, *B.*, *H.*, *Ng.*, stylobates, *H.*, *Hw.*, *N.*, viscosa, *B.*, vitilis, *I.*

Naucoria arvalis, *N.*, cucumis, *B.*, escharoides, *H.*, semi-orbicularis, *N.*, scolecina Fr. sensu Lange, *B.*

Nolanea cetrata, *B.*, *H.*, infula, *H.*, staurospora, *B.*, *H.*, *I.*

Nyctalis parasitica, *Hw.*, *V.*

Omphalia fibula, *H.*, *V.*, integrella, *H.*, pyxidata, *N.*, umbellifera v. nivea, *Hw.*, *I.*, umbilicata, *B.*, wynniae, *Hw.*

Paneolus campanulatus, *I.*

Paxillus involutus, everywhere.

Pholiota erebia, *H.*, *V.*, flammans, *V.*, marginata, *B.*, mutabilis, *B.*, spectabilis, *V.*, squarrosa, *U.*, togularis *B.*
Pleurotus dryinus, *B.*, ostreatus, *Hw.*, porrigens, *B.*, *Hw.*
Pluteus nanus, *B.*
Porphyrellus porphyrosporus, *B.*, *Hw.*, *V.*
Psalliota arvensis, *N.*, *V.*, augusta, *V.*, sylvatica, *H.*
Psathyrella disseminata, *Hw.*, *V.*, fibrillosa, *B.*, gracilis, *B.*, *V.*
Psilocybe ammophila, *N.*, coprophila, *I.*, *N.*, elongata, *B.*, *I.*, foenisecii, *N.*, *V.*, polytrichi, *I.*, sarcocephala, *B.*, semi-lanceata, *H.*, *I.*, *V.*, spadicea, *B.*, uda, *N.*
Ripartites tricholoma, *V.*
Russula adusta, *B.*, *Hw.*, *V.*, aeruginea, *H.*, amoena, *H.*, *Hw.*, atro-purpurea, *B.*, *H.*, *Hw.*, *V.*, claroflava, *B.*, coerulea, *V.*, cyanoxantha, *B.*, *H.*, *Hw.*, *V.*, delica, *B.*, *V.*, dreimeia, *B.*, *I.*, *V.*, emetica, *Hw.*, *I.*, *V.*, exalbicans, *N.*, fallax, *B.*, *V.*, farinipes, *B.*, *V.*, fellea, *B.*, *Hw.*, *V.*, foetens, *B.*, *V.*, fragilis, *B.*, *Hw.*, *I.*, *V.*, heterophylla, *B.*, *V.*, integra, *I.*, lepida, *B.*, nigricans, *B.*, *H.*, *Hw.*, *V.*, ochroleuca, *B.*, *Hw.*, *I.*, *N.*, *V.*, sororia, *V.*, versicolor, *V.*, vesca, *I.*, *V.*, veternosa, *Hw.*, *V.*, xerampelina, *B.*, *I.*, *N.*, *V.*, xerampelina v. erythropus, *I.*, xerampelina v. fusca, *B.*
Stropharia aeruginosa, *H.*, *I.*, *N.*, *V.*, coronilla, *N.*, semiglobata, *B.*, *I.*, *N.*, *V.*
Tricholoma album, *V.*, atrocinereum, *N.*, *U.*, *V.*, carneum, *N.*, *V.*, cuneifolium, *U.*, fulvum, *B.*, imbricatum, *H.*, ionides, *N.*, leucocephalum, *B.*, melaleucum, *B.*, *N.*, nudum, *N.*, ramentaceum, *N.*, rutilans, *B.*, *H.*, *Hw.*, *I.*, *V.*, saponaceum, *B.*, *Hw.*, *V.*, saponaceum v. squamosum, *B.*, *Hw.*, sulphureum, *V.*, terreum, *V.*, ustale, *B.*
Tubaria furfuracea, *B.*, *N.*
Volvaria speciosa, *N.*

Aphyllophorales

Clavaria acuta, *Hw.*, cinerea, *B.*, *Hw.*, cristata, *B.*, *V.*, formosa, *B.*, fumosa, *H.*, *V.*, fusiformis, *H.*, *V.*, rugosa, *B.*, *H.*, *V.*, vermicularis, *V.*
Corticium praetermissum, *H.*, sambuci, *V.*
Daedalea quercina, *B.*, *V.*
Fistulina hepatica, *B.*
Fomes annosus, *B.*, *H.*, *Ng.*, *V.*, connatus, *V.*
Ganoderma applanatum, *V.*
Hydnum auriscalpium, *V.*, repandum v. rufescens, *B.*
Hymenochaete rubiginosa, *B.*
Peniophora cinerea, *V.*, gigantea, *V.*, quercina, *V.*
Polyporus betulinus, *B.*, *V.*, caesius, *B.*, *H.*, *Ng.*, chioneus, *B.*, fragilis, *B.*, *H.*, *V.*, frondosus, *B.*, giganteus, *B.*, perennis, *Ng.*, *V.*, radiatus, *B.*, squamosus, *V.*, varius, *B.*
Polystictus versicolor, *Ng.*, *V.*
Poria candidissima, *H.*, sanguinolenta, *B.*, *H.*, *V.*
Ptychogaster alba, *B.*, *H.*, *Ng.*
Sparassis crispa, *H.*
Stereum gausapatum, *V.*, hirsutum, *B.*, *N.*, *V.*, purpureum, *V.*
Thelephora terrestris, *N.*, *V.*
Trametes mollis, *V.*, rubescens, *B.*

Tremellales

Exidia glandulosa, *B.*
Tremella encephala, *H.*
Tremellodon gelatinosum, *V.*

Calocerales

Calocera cornea, *B.*, viscosa, *B.*

Gasteromycetes

Bovista plumbea, *N.*
Cyathus olla, *N.*, striatus, *B.*
*Geaster schmidelii Vitt., *N.*
*Hydnangium sp., *B.*, *V.*
Hymenogaster citrinus, *V.*, vulgaris, *B.*, *V.*
Lycoperdon gemmatum, *B.*, perlatum, *B.*, *Hw.*, *V.*, pyriforme, *B.*, *Hw.*, saccatum, *Hw.*, umbrinum, *B.*, *H.*, *Hw.*
Melanogaster variegatus v. broomeianus, *V.*

Mutinus caninus, *B.*, *H.*
Phallus impudicus, *B.*, *H.*, *N.*, *V.*
Scleroderma aurantium, *B.*, verrucosum, *Hw.*, *V.*

(*Note. Hydnangium* sp. is a new record for Britian and probably a new species. It is under investigation and will be described later in a note in the *Transactions*.)

FUNGI IMPERFECTI

Actinonema rosae (Lib.) Fr., on *Rosa* sp., *Hw.*
Alatospora acuminata Ing., *H.*, *Ng.*
Anguillospora longissima Ing., *Ng.*
Articulospora tetracladia Ing., *H.*, *Ng.*, inflata Ing., *H.*
Bispora monilioides Corda, *V.*
Botrytis cinerea Fr., *B.*
Clavariopsis aquatica de Wild., *H.*, *Ng.*
Cylindrodendrum album Bon., on alder catkins, *B.*
Flagellospora curvula Ing., *H.*, *Ng.*
Illosporium roseum Fr., on *Parmelia*, *B.*
Lemonniera aquatica de Wild., *H.*, *Ng.*
Leptostroma pinastri Desm., on pine needles, *B.*
Oidium alphitoides Griff. & Maubl., *B.*
*Pestalotia monochaeta Desm. v. gallicola Trotter, *B.*
Phyllosticta hedericola Dur. & Mont., *H.*
Psammina bommeriae Rouss. & Sacc., on *Ammophila arenaria*, *N.*
Ramularia lactae Desm., *H.*, lapsanae (Desm.) Sacc., on *Lapsana communis*, *Hw.*, urticae Ces., on *Urtica dioica*, *B.*, *Ng.*, *V.*
Sepedonium chrysospermum Fr., *B.*, *V.*
Septoria geranii Rob. & Desm., *H.*, stellariae Rob. & Desm., on *Stellaria media*, *V.*
Tetrachaetum elegans Ing., *H.*, *Ng.*
Tetracladium marchalianum de Wild., *Ng.*
Trichoderma viride Pers. ex Fr., *V.*
Tricladium gracile Ing., *H.*, *Ng.*, splendens Ing., *H.*, *Ng.*
Tubercularia vulgaris Tode ex Fr., *B.*

MYCETOZOA

Arcyria denudata Wettstein, *H.*
Ceratiomyxa fruticulosa Macbr., *B.*, *H.*
Comatricha pulchella Rost., *N.*
Cribraria vulgaris Schrad., *H.*
Leocarpus fragilis Rost., *B.*
Lycogala epidendrum Fr. *H.*, *V.*
Mucilago spongiosa Morg., *C.*

LONDON AND LOCAL FORAYS

Three forays were held in the London area: Mad Bess, Copse, and Park Woods, Ruislip, Saturday, 30 September; Knole Park, a first visit, Sunday, 8 October; Oxshott Heath, Saturday, 14 October. The Sorby Natural History Society held three forays: Chatsworth, Sunday, 10 September; Eccleshall Woods and Limb Valley Woods, Saturday, 14 October; Cordwell Valley, Sunday, 15 October. A foray to Lickey Hills was organized by the Botany Department of Birmingham University on Sunday, 8 October.

In contrast to recent years, fungi were plentiful or abundant in all areas, to the delight of many young students who had previously seen only meagre collections.

THE TWENTY-FOURTH ANNUAL PLANT PATHOLOGY FIELD DAY

9 June 1950

The Twenty-fourth Annual Field Day was held, by kind permission of the Director, at the Experimental and Research Station, Cheshunt. About 60 members attended.

Dr W. F. Bewley welcomed the party and gave a short account of the history and aims of the station. He then conducted a tour of the glasshouses where experiments on the cultivation of cucumber, tomatoes and, to a much smaller extent, on carnations and other flowers were being carried out.

After a sandwich lunch, kindly provided by the Station, members spent the afternoon in the laboratories. In each department members of the staff arranged excellent demonstrations and readily discussed their work. Naturally much interest was shown in the work being done in the Mycology Department particularly that on *Didymella lycopersici* by Mr P. H. Williams and on the fungi associated with root rot of tomato by Miss Ebben.

Members were again the guests of the Station at tea. Dr G. C. Ainsworth, the President, supported by Dr S. D. Garrett, Chairman of the Plant Pathology Committee, thanked Dr Bewley and his colleagues for their hospitality and for the interesting programme they had provided.

F. Joan Moore
Secretary, Plant Pathology Committee

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INSTRUCTIONS TO AUTHORS

Contributors are asked to be clear and concise, and to use a recent issue of the *Transactions* as a guide to the arrangement of headings and subheadings, explanations of plates and figures, references to the literature, and other details. Each paper should start with a short summary.

The standards adopted in the *Transactions* are those outlined in the Royal Society's pamphlet, *General Notes on the Preparation of Scientific Papers* (1950, Cambridge University Press, 200 Euston Road, London N.W. 1, price 2*s*. 6*d*.). An exception is that in the *Transactions* citations of references to literature, although based on the Harvard system, include the full titles of the papers and complete page numbers. Titles of journals are abbreviated in accordance with *A World List of Scientific Periodicals*, 1934.

The scientific names of genera and species are printed in italics and should be underlined in the typescript. The title of the paper, headings, and subheadings may be in capitals, but should not be underlined.

The attention of authors proposing new taxonomic groups is drawn to the need to give an adequate description and figure, and to designate the types as required by the *International Rules of Botanical Nomenclature*. The description of a new species should be accompanied by a figure, and whenever possible the type specimen should be deposited in one of the national herbaria.

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